New York, May 18, 1921 McGraw-Hill Co., Inc. Vol. 24, No. 20, 25c. a copy

CHEMICAL & METALLURGICAL ENGINEERING

Thirty Miles of It—

Throughout the eight big buildings of the Youngstown Pressed Steel Company of Warren, Ohio, there run thirty miles of diversified piping.

Thirty miles of it! Pipes carrying compressed air to drive the enormous steel presses, fuel oil piping to furnaces, acid piping to pickling vats, live steam, hot water, cold water, power piping, naphtha piping and all the miscellaneous work—and every inch of it Grinnell!

That the owners were justified in placing the entire contract with Grinnell Company is evident from their statement: "The whole installation is a model of economy and efficiency."

This job is a fair demonstration of the scope and effectiveness of Grinnell Company's Piping Service. Modern engineering and a skilled road force of 1300 men have made such service possible. Grinnell Engineering is as practical as it is creative, as sure in its results as it is courageous in its pioneering. On every installation Grinnell Company places *a courageous guaranty behind ideas, men and materials.*

Send for your copy of the "Grinnell Bulletin" ....Address Grinnell Company, Inc., 268 West Exchange Street, Providence, R. I.

GRINNELL
INDUSTRIAL PIPING
Automatic Sprinkler Systems, Heating, Power and Process Piping
Your kind, their kind, every kind of Piping

This part of the 30 miles of piping at Youngstown Pressed Steel Company, Warren, Ohio, efficiently heats the enormous factory area in even the bitterest weather.

Shriver Efficiency

Many years of producing filter presses for all types of filtration work enable us to guarantee the results.

This guarantee of efficiency goes with every filter press we sell—we know our product, and we are ready to stand back of it. Write for catalog stating your filtration problem.

T. SHRIVER & CO.
808 Hamilton Street, Harrison, N. J.

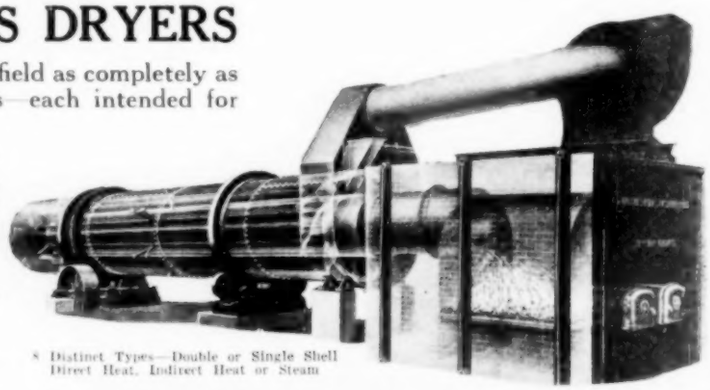
RUGGLES-COLES DRYERS

We have endeavored to cover the drying field as completely as possible through our eight standard types—each intended for the drying of specific materials.

Operators of Ruggles-Coles Dryers are assured of high quality drying, absolute safety and highest thermal efficiency. In addition, Ruggles-Coles Dryers possess unusual strength and long life, bringing to their users lowest operating and maintenance costs.

We are well prepared to build special dryers for materials of unusual characteristics.

Ruggles-Coles Engineering Company
120 Broadway, New York City



8 Distinct Types—Double or Single Shell
Direct Heat, Indirect Heat or Steam

CHEMICAL CENTRIFUGALS

"The Finest Extractor Made"

That's what most engineers said at the 1920 National Chemical Exposition on seeing the

"Hercules-Electric"

Patents Pending

Self Balancing—Bottom Discharge

Sizes 6 to 60 inch

Eastern Representative:
F. A. TOLHURST
40 So. 7th St., Philadelphia, Pa.

Southern Representative:
E. S. PLAYER
Greenville, S. C.

Canadian Representative:
WHITEHEAD EMMANS, LTD.
285 Beaver Hall Hill, Montreal, Canada

EAST JERSEY PIPE CO.- PATERSON.N.J.

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
WALLACE SAVAGE
Assistant Editor

ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 24 | New York, May 18, 1921 | Number 20

Chemical Industry and The Department of Commerce

IN THE brief time that Mr. HOOVER has been Secretary of Commerce he has given ample evidence of his desire so to conduct the Department as to be of maximum service and benefit to industry. As far as we can observe, his activities do not contravene the expressed policy of the Administration to have "more business in government and less government in business." The function of the Department of Commerce is not to regulate industry but to serve it; and Mr. HOOVER'S name is synonymous with service.

Three bureaus of the Department are of particular interest to the chemical industries, namely, the Bureau of Standards, the Bureau of the Census and the Bureau of Foreign and Domestic Commerce. Significant of Mr. HOOVER'S estimate of the importance of these bureaus is the fact that in the organization of his department he plans to give them his personal attention. Further to study the relation of these bureaus to industry and expand them as aids to business Mr. HOOVER has selected as his personal assistant F. M. FEIKER, vice-president and chairman of the Editorial Board of the McGraw-Hill Co. Mr. FEIKER'S engineering training, knowledge of industry and sense of publicity qualify him exceptionally for this work. The extent to which these three bureaus can serve depends largely upon the support received from Congress, and we believe that the chemical industry can well support the request of the Department for an appropriation of about $600,000 which is now before the Committee on Appropriations. A favorite method of comparison of all appropriations is to relate them to the huge sums requested for the support of our military establishment. In these terms Mr. HOOVER'S request is for a sum said to be equivalent to the cost of only one battalion of troops for one year.

In planning the work of the bureaus mentioned, three points of view are being kept in mind: First, the broad problem of building up a closer contact between the Department and industry; second, the necessity of developing fuller statistical data; and third, a study of industry to discover those areas in which standardization and simplification can be applied to advantage and without detriment. Approximately $250,000 is being asked for the purpose of building up a closer contact with industry. This will probably be done through the medium of industrial service committees within the Department, comprising perhaps a dozen groups of workers, each headed by a man familiar with the conditions of a particular industry. These industrial service committees will be advisory to the Secretary in determining what the Department can best do for the different industries. In improving the statistical service of the Department five items of prime importance will be considered: 1, statistics of production; 2, statistics of stocks; 3, the percentage activity in an industry; 4, prevailing basic prices, and 5, the prompt issuance of a report so that the figures will be of current value. The third point of service—the matter of standardization and simplification—is one to which a considerable part of the requested appropriation, say $350,000, probably will be devoted. Here again a series of industrial service committees will be the medium through which the problem will be attacked.

Our readers will learn with satisfaction that the Secretary of Commerce is in thorough accord with the program of economy to which the Government is committed and that he has not asked for new appropriations without first effecting economies within his Department in a sum aggregating several times the amount now requested of Congress. In view of this attitude and the evidence of careful study and planning for the expenditure of the money not only for the benefit of industry but largely under its own advice and direction, we feel quite justified in urging representatives of the chemical industries to support Mr. HOOVER'S request for appropriations.

Professional Services Recognized In Proposed Classification

FAVORABLE recognition is given to professional men in the Government service by legislation introduced at this session of Congress by Mr. WOOD of Indiana and Senator SMOOT of Utah. This legislation provides for "an equitable system for the valuation of the services of civilian employees of the Government," and the professional workers are gratifyingly appraised in the terms of the proposed legislation.

If this Wood-Smoot bill becomes a law the junior-chemist grade will begin at $1,860 and provision will be made for the higher technical positions up to salaries of $7,500. The bill very frankly recognizes that it is impossible to define in words the ranks or qualifications of different professional positions. Indeed it uses almost identical language for all of the places in scientific work from $2,500 to $7,500 per year and says regarding them that "the distinction between grades is based upon differences in the training and experience required in the work."

We are prone to think that our national legislators are slow to recognize the urgent necessities of professional positions. In the past they doubtless have been. But this is a most encouraging sign, and one which industrial executives employing professional chemists can do well to emulate. The term "chemist" is so broad in meaning that arbitrary fixing of salaries for those qualified for the title is wholly impossible. Let us hope that Congress will officially confirm the proposed plan of Government classification and that our industrial organizations as well will recognize that "distinction between grades is based upon differences in the training and experience required in the work."

A Great Obligation

SOME very interesting statistics have lately come to light. In 1890 there were about 200,000 pupils attending secondary schools in the United States. That means children, or, rather, adolescents who are engaged in courses beyond the eight years required. Whether these are public high schools, or the four upper forms of boarding schools such as Exeter or Andover, or military academies, or what we call private and our British cousins call public schools such as St. Paul's or Groton, or Roman Catholic institutions, makes no difference. It represents the standard four years of education following the grammar school course and leading to matriculation in colleges and the higher institutes of technology. By 1900 there were upward of 900,000 such pupils in the United States. Today the number is over 1,600,000. This number represents more than one-half of the young persons in the world who are enjoying secondary education.

What does it mean? Our population has not increased in any such ratio. It tells us that Young America wants to learn.

In the United States Army a series of continuation schools has been introduced. These have to do with trades rather than with professions, but it represents study. Every prescribed occupation is analyzed into a definite number of things that a plumber, a carpenter, a mason, etc., must know how to do. The courses are definitely laid out, and more than 60,000 United States soldiers are now studying at these various trades.

But what does it all mean? The curricula are hardly satisfactory; many school systems still languish in the throes of politics; we do not respect teachers or give homage to the few men and women who are by nature exceptionally gifted to practice the greatest of all arts, which is that of teaching; we quarrel among ourselves as to whether somebody shall read a chapter from the Bible or not, but we do not bother about ethics—and yet there are over a million and a half students eager to learn, and "we leave it to the authorities." The authorities are usually politicians, and what they are after is votes.

What are these young people learning, and how shall we meet them? Will they learn that it is better to do work well than to tell somebody else to do it? Here is a great thesis in the philosophy of life. Every real artist knows the joy of work, and so does every true mechanic who has the privilege of liberty. Now, liberty is a much more restricted concept than most of us think it is. There is no such thing as absolute freedom. But why should we not enjoy such liberty as we have?

There is the man, for instance, who works eight hours a day. When the whistle blows or the bell rings his task is finished. Eight or nine hours is all the time he wants for sleep, and the rest is his. If he loves the arts or music or literature or is interested in the sciences, he has the opportunity not only to improve his mind but to enjoy life. He can do what he wants to do under his own rights and privileges. He is a remarkably free man. The superintendent of the works, on the other hand, the man who commands, is little more than a slave. He has given hostages for his position and salary. His work is never finished. He is engaged in administration, and administration is intellectual slavery. He can't do what he wants to do, because something is always going wrong—if he is competent and has the wit to see it. The only leisure he knows is rest; detective stories, movie shows and musical comedies are the substance of his recreation. He can't develop his mind beyond the interests of the corporation which he serves. He lives an unenviable life.

Now, the question which intrigues us is whether, with this increased education, our young people will learn this fact. Ordinary common labor today is as remunerative as, and even more so than, two of the learned professions: Teaching and divinity. It pays better than the early years, as a rule, of engineering or law or medicine. It is a dignified occupation to work with our hands. And if we are gifted with sanity and a useful mind, we can find contentment in it. But scorn is the enemy of contentment, and those of us who employ others will need to bear this fact in mind as keenly as those who work for us will sense it.

It is a proud thought to consider half of the high school pupils of the world as being in the United States. But unless we meet it right it may be anything but a blessing. It confers a new and greater obligation on those of us who lack the greater freedom because we direct affairs.

Technology Brings Youth to Industry

Every Youthful Minute is a Precious Inch of Gold!

ARGUMENTS between executive and sales manager are rather common occurrences at all seasons of business, but they happen with increasing frequency during the late afternoons in these depressing times. They are not always fruitful of so much good as in the following instance, with quotations practically verbatim:

PRESIDENT—But we can't quote as low a price as the Burnt Clay Co. It costs us more than that to make the stuff.

SALES MANAGER—Certainly it does. Why? Because you are using antiquated methods in producing the ware. They date back beyond the time of the Mound Builders. You are mixing by "feel," hand-molding standard ware, conveying by wheelbarrow and burning the clay by the "expert's" eye. Why, your plant man told me the other day that he had pyrometric cones in the office "in case he ever needed them." And if you showed him a recording pyrometer he'd think it was an attachment for a steam engine or an automobile. If your plant were operated with a definite knowledge of materials you are handling and producing you wouldn't have to fear anybody's price.

PRESIDENT (With frown, grin and frown)—That's enough, young fellow. If you know so much about this new scientific-stuff-in-industry business, I'm going to give you a chance to run the plant for a while, even to long-necked bottles, glass-covered scales and the rest of the tricks.

The upshot of this conversation was that the sales manager shortly became superintendent of plant with considerable authority to make changes. Fortunately he was a man with some intimate knowledge of the business all along the line from the clay pits to marketing the product. He knew the old way, but had gained young ideas.

This actually took place several months ago and if the reader could take a walk through the works with him now, see the changes made and in the making; note the economies effected by rearrangement of operations, the reasonable amount of new equipment installed for further cost-per-unit decreases and listen to his discourse on plans for a future scientific control laboratory to get uniform quality of product, he would realize that

the president acted with canny foresight when he gave this chap plenty of leeway.

The next best thing to being a live one is for a man to realize he's a dead one. It is not hard to see why this executive has attained a place in his chosen business. When it had developed beyond the knowledge of his time, he called in youth to carry it on, wherefore he should enjoy the progress and incidentally a few more "inches of gold."

Labor Unions and Industrial Decay

REPRESENTATIVES of the labor unions before the Railroad Labor Board have made the claim that the railroads are wasting at least $1,000,000,000 a year through mismanagement, and assert that wages should not be touched until all the leaks are stopped. There is an inconsistency in the position, in that the claim has likewise been set up that the ability of the railroads to pay wage rates should not be considered. The *Railway Age* points out the absurdity of the $1,000,000,000 claim in another way, observing that last year's railroad operating expenses were $6,300,000,000, of which $4,000,000,000 would be absorbed by wages, leaving $2,300,000,000 out of which the $1,000,000,000 would have to be saved, so that the other expenditures would have to be reduced by about 45 per cent.

The United Mine Workers have a wage scale, arranged when all costs and prices were practically at their peak, and which was high even for those conditions. This scale is signed to April 1, 1922, and apparently is not susceptible of modification meanwhile.

Wages in the building trades are very high, for a day's work or a week's work, and they are much higher still on the basis of the quantity of work done by the artisans in a day. The usual dates for annual settlements of the scales in the building trades are May 1 and June 1, and very few reductions have been made. In several districts strikes are now on.

The average observer of business conditions, if he gave no thought to the fact that the railroad workers and the workers in the building trades are well organized, would undoubtedly say that two of the prominent things that are retarding a return of industrial activity are the high costs of railroading and of building. The cost of mining coal is also very high, but that fact receives little attention simply because people do not want coal just now in any quantity.

If from the total of labor unionism in the United States there be subtracted the unions on the railroads, in the building trades and in the coal mines there is very little left. Of all the workers in the country only between 10 and 15 per cent belong to unions, and if the three monopolies are subtracted only a very small per cent is left.

These three classes of unionism must be taken as representing what unionism means. They represent conditions where unionism is successful. If now we should estimate all the work that should normally be done in the United States and allot it by percentages to crafts, the proportion allotted to coal mining, building and operation of the railroads would be far less than the percentage of wage drawers that are now in these lines of activity.

What does this mean but that these men are not doing their share of the work of society? They are drones, relatively speaking, supported in part by the rest of the workers. It is not so much that they receive too much money for a day's work as it is that they do not render a full day's work. In this respect they may not differ from their non-union associates, except that they have the power of organization to enforce their ideas. But suppose that unionism should spread and the attempt be made to fasten the principle upon all lines of work. Who would be left to pay the bill? What would be the result of the effort?

The answer to the question was given by Judge GARY at the recent annual meeting of the stockholders of the United States Steel Corporation. It being the twentieth anniversary, Judge GARY reviewed the "principles and policies" of the corporation. He dwelt upon its attitude in being so strongly committed to the "open shop," saying: "The natural and certain effects of labor unionism are expressed by three words: Inefficiency; high costs." And again: "I firmly believe complete unionism of the industry of this country, as attempted, would be the beginning of industrial decay." Perhaps; and yet maybe no more so than would be true of complete domination by capital. However, Judge GARY has given the answer to the question what would occur if the principles and practices of the railroad unions, the building trades unions and the United Mine Workers were forced upon the entire body of workers. There would be no one left to pay the bill.

Germany Bows To the Inevitable

WITH Germany's acceptance of the demands of the allied governments she assumes a burden which her people can lift only through persistent effort. Ever since the Armistice there has been considerable speculation as to when Germany might recover her commercial status among the world's nations and how that end would be attained. The matter is of more than ordinary interest to the chemical industry because of Germany's former pre-eminence therein. It is timely, therefore, to speculate on the prospects. Considering the German's character it seems likely that under stress of fulfilling the terms of the Peace Treaty he will develop a degree of efficiency and excellence in production such as the world has never seen. In this he will be aided by the government, which will subsidize him through food sold below cost and other similar devices. The consequence may be that for a time the German will appear to be rapidly regaining his lost industrial prestige, with proportionate menace to the industry of our own and other countries. With respect to ourselves, however, the other side of the picture is that the German has no conception of quantity production such as we commonly see in the United States; nor has he a large domestic market for the consumption of his product. Added to this is the inevitable fact that some day he must reap the real harvest of government subsidy of business and come face to face with the necessity of competing with the other nations of the world on an equitable economic basis. With anything like maximum production in this country and with a large and increasing domestic market the United States has little or nothing to fear from German competition. This will be true, however, only by increasing efficiency of production, because we will be forced to meet competition under a low standard of living that must continue in Germany and on the Continent for at least a generation.

Readers' Views and Comments

The Valentiner Vacuum Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—While I was absent from the country your résumé of my extemporaneous talk on nitric acid before the Delaware Section of the American Chemical Society appeared in the March 9 number of CHEMICAL & METALLURGICAL ENGINEERING, page 443. In this abstract I note the statement on page 445 that "the Valentiner vacuum process proved to be a failure commercially."

Though I may have conveyed this impression in my talk, it was far from my intention to do so, because this process is operating successfully in this country and also in Germany today. What I wished to bring out was that the vacuum was originally employed to enable the retort reaction to be carried to completion at a lower temperature, but this caused foaming and a tendency for the soda to float on the top of the charge, unduly lengthening the time of distillation; consequently the device was adopted of throttling the gases at the exit of the retort (see U. S. Pat. 920,224, to F. S. Valentiner), thus putting the retort under pressure but keeping the condensation and absorption systems still under a vacuum.

This, I pointed out, was exactly the opposite of what is desired theoretically to obtain the best results.

Condensing and absorbing under a vacuum does, however, produce a water-white acid, and for manufacturers of this grade of acid the larger equipment and the additional pumps, etc., of the Valentiner process are doubtless justified. For ordinary commercial grades of acid for nitrating purposes it seems doubtful, however, whether the Valentiner process can compete with the ordinary distillation at atmospheric pressure from the cost standpoint.

F. C. ZEISBERG.

Wilmington, Del.

Treatment of Acid and Alkali Burns

To the Editor of Chemical & Metallurgical Engineering

SIR:—In his instructive article on "The Treatment of Acid and Alkali Burns," printed in your issue of April 27, Dr. A. K. Smith does not mention hydrofluoric acid; though he does mention the perhaps less common and certainly less dangerous chromic acid, including it inadvertently under "caustics."

During a long experience in charge of manufacturing operations I have had frequent opportunity to observe the effects of various acids on living tissues and there is, I think, none more dangerous than hydrofluoric in the higher concentrations. This acid has, in some cases at least, the peculiar and insidious property of inducing something like a partial anæsthesia in the tissues with which it comes in contact. At first there may be only a period of minor irritation, of duration and intensity varying with the individual but which frequently causes the careless or uninstructed to delay or neglect proper prophylaxis. Later comes agonizing pain, with tissue destruction and a wound of unhealthy character, very slow in healing. With deference to Dr. Smith's greater technical knowledge of this subject, I must say that I think I have observed in acid burns a poisonous effect extending beyond the initial destruction of tissue. This effect seems most marked with hydrofluoric, less so with nitric, and least with sulphuric. An additional malignant property of hydrofluoric is the effect of its vapor, especially in contact with the finger nails. Hours of misery have followed prolonged holding of a rubber stopper wet on the lower end with the concentrated acid; and following one occasion on which I got a particularly bad dose of the vapors on the fingers blood extrusions began to grow out under two finger nails after a few days. I have seen workmen pass periods of profane discomfort after handling barrel bungs with unprotected fingers, though there were no visible effects on the skin.

Yes, "hydroflu" is surely worthy of a place in Dr. Smith's list. As a destructive fluid I place it second only to some of the home-brewed "hootch" with which our western Pennsylvanians corrode their interior mysteries. I used to make the stuff—the hydrofluoric—in Long Island City, but even along Newtown Creek it was found unbearable, and we were chased to a site on the Jersey marshes, bounded on one side by the Hackensack River and on the three others by a population of scientific workers for whom all metals had magnetic properties and were convertible into various forms of CH_3OH—all, that is, but the lead of our HF equipment. That was as safe as soap in Petrograd; and the merry villager whose favorite outdoor sport was to shatter the unprotected carboy of vitriol or nitric into smoking ruin with an indigenous brick made devotional gestures as he passed—on the far side of the road—the ranked lead boxes of hydrofluoric awaiting shipment.

Seriously, though, it is desirable to advertise that this widely used and indispensable acid is highly corrosive to tissues, and requires special precautions in handling because of the unusual properties already mentioned.

One other word might supplement Dr. Smith's advice. That is the necessity, where large quantities of strong sulphuric acid have reached skin and clothing, of using the largest possible quantity of water and continuing its application for a considerable time. If the acid has saturated any part of the clothing, only a copious and continued drenching—preferably an immersion—will keep the burn from being seriously intensified by the heat produced from contact of water and acid.

Canonsburg, Pa. DALTON M. GOETSCHIUS.

Porcelain Enameling Furnaces

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of April 6 you published a letter from Francis A. J. FitzGerald concerning electrically heated porcelain enameling furnaces. It may be of interest to your readers to know that in the April and June numbers of the *Journal of the American Ceramic Society* there will be published two papers describing commercial installations of furnaces of this type.

E. W. WASHBURN,
Editor

Urbana, Ill.

Award of the Nichols Medal to Gilbert N. Lewis

Proceedings of Meeting—Appreciation of Medalist and Personal Reminiscences—Address on Color and Chemical Constitution With Regard to the Subatomic Structure and the Nature of the Electron Bond

THE Nichols Medal was presented Friday evening, May 6, to Dr. Gilbert N. Lewis, of the University of California, for the best original paper published in any of the journals of the American Chemical Society during the year 1920, and in the judgment of the jury this best paper was the one entitled "The Third Law of Thermodynamics and the Entropy of Solutions and of Liquids," by the recipient and G. E. Gibson.

An Appreciation of the Medalist

BY ARTHUR B. LAMB

I am very glad of my opportunity this evening to say something about the achievements and personality of G. N. Lewis. As we have him with us here in the flesh, I will endeavor to make my remarks about him seem as little like an obituary as possible; I have come, not to bury Cæsar, but laud him.

My acquaintance with him began eighteen years ago, when as a graduate student at Harvard I listened to his lectures on electrochemistry and thermodynamics. Lewis had graduated from Harvard College several years before, in 1896, had taken his Ph.D. in two years of graduate work, had taught a year at Phillips Exeter Academy, and was then back at Harvard as an instructor. In these lectures Lewis accomplished the real *tour de force,* of kindling our interest in and enthusiasm for such subjects as entropy, free energy, and a special thermodynamic function all his own, which he had christened "fugacity." His lectures were remarkable in still another respect. He covered thoroughly an enormous amount of ground. Throughout his lectures Lewis kept pacing back and forth across the platform, covering miles at breakneck speed. From Harvard Lewis was called to a professorship at the Massachusetts Institute of Technology, and a few years later left to be head of the department of chemistry at the University of California.

NATURE OF CHEMICAL AFFINITY

At the outset I must call your attention to a striking coincidence. Sir Isaac Newton in his "Principia" says: "There are agents in Nature able to make the particles of bodies stick together by very strong attractions. And it is the business of experimental philosophy to find them out." Newton thus recognized and propounded the problem of chemical affinity, and this is the very problem which has been the main object of attack in the many brilliant researches of our medalist, Gilbert Newton Lewis, in part therefore at least the namesake of his great predecessor.

Evidently one way to study the nature and magnitude of chemical affinity is to find out the amount of heat and other forms of energy which it can produce. Lewis in his doctor's thesis and in his first independent published article made important advances in this direction. He developed on thermodynamic grounds a general equation of chemical affinity and showed how in favorable cases by its means the extent of a chemical reaction could be computed from thermal and physical data. More important still, he showed in this article for the first time that a complete solution of this problem required a knowledge of certain then indeterminate constants characteristic of the particular varieties of matter under consideration. It was a study of these very constants which later led others to formulate what is now called the Third Law of Thermodynamics, which Lewis himself has further clarified in the paper for which the Society is now conferring the Nichols Medal —namely, "The Third Law of Thermodynamics and the Entropy of Solutions and of Liquids."

Between this first paper and this last one Lewis has published a score and more of articles dealing with the chemical affinity of a great variety of substances. Certain of them have been particularly important—for instance, his determination of the free energy of formation of water at room temperatures, and also his determination with Dr. Kraus for the first time of the potential of the sodium electrode.

RELATIVITY AND A SYSTEM OF VECTOR ANALYSIS

Lewis has not been content to confine his studies even to so broad a field as chemical affinity. He was practically the first American to discover Einstein. As far back as 1909 he published a paper on "Relativity" in which he developed a new system of vector analysis which facilitated the further study of this subject, and later he developed a wholly new system of non-Euclidian geometry and vector analysis which appears to offer many advantages in the solution of recondite mathematical problems. One can thus see that Lewis in these papers has gone over from the field of chemistry into what is pure mathematics. In this connection it is interesting to point out that he never took any courses in mathematics higher than analytical geometry. He studied the calculus and higher mathematics by himself as a form of recreation.

MILITARY ACTIVITIES

As illustrating still another side of Lewis' mentality and personality, I want to tell a little about his activities during the war. He went to France in the first months of 1916 with Colonel Bacon's contingent in the Chemical Warfare Service. General Fries sent him very soon to act as observer for the Chemical Warfare Service with the Fifth British Army. Lewis had hardly arrived there when the Germans launched their great offensive against that army. It was a thrilling experience, but a valuable one. Lewis withdrew in good order along with the rest of the army, but the closeness of the call may be judged from the fact that he is said to have left his Sam Browne belt behind him. But this did not prevent Lewis from accomplishing

his purpose. On his return he presented a report to General Fries on the progress of this battle and its significance and lessons from the chemical warfare point of view, which General Fries told me was the most suggestive report even from a strictly military point of view of this engagement which he had read. Up to this time General Fries had been unable to secure a satisfactory chief for the Defense Division of the Chemical Warfare Service. Two colonels in the regular army had held this position, but the problems to be faced were so novel and so foreign to their training and education that they had been unsuccessful. General Fries appointed Lewis to this position and he served with conspicuous success.

Personality

Finally, I cannot close without saying something more specific about the personality of our medalist. Though his intellectual and professional interests are prodigiously highbrow, as I have shown you, he is nevertheless just as keen as the rest of us about more ordinary things. He plays a dashing and successful game of three-handed bridge, where his venturesome instinct finds free scope, but at chess these very tendencies often prove his downfall. With or without the stimulus of ethyl alcohol, in any company he is the focus of the liveliest discussion and the center of the merriest group. Indeed, to describe this side of his personality I cannot do better than adopt the phraseology of the day, though perhaps it is already that of yesterday. Lewis is a "regular fellow."

Some Personal Reminiscences

By John Johnston

I also am very glad of the opportunity to say a few words in appreciation of Gilbert Newton Lewis, whom you have chosen to honor by award of the Nichols Medal this year. But I am in somewhat of an embarrassment because I find that the things I had planned to say have already been said by my predecessor. We agreed at the Rochester meeting that he should talk more about the thermodynamic papers and I was to talk more about the others; but I find that he spread over into my assignment, and I didn't know that until at dinner tonight when we exchanged papers, I having written down what I proposed to say, coming on the train today, and Mr. Lamb having done likewise. But perhaps you will believe us more when we both agree, because you remember that—isn't it in "Alice in Wonderland" that someone there says, "What I say three times is true"? Therefore, what two different people say once each ought to be as true as what any common person says three times.

I met Mr. Lewis for the first time on the day that I first arrived in Boston in 1907. He took me to lunch, introduced me to my first cocktail as such—or perhaps I should say introduced my first cocktail to me, and ordered among other things corn on the cob, which I had never seen before—I think partly in pursuance of a scientist's curiosity to see just what would happen. This was but the first of very numerous meetings during the year that I spent in Boston. I also know about his proficiency at auction bridge and can confirm exactly what Mr. Lamb said about it. These frequent meetings with him led me to form a very high opinion of him, both as a scientist and as a companion and friend, and nothing since has given me reason to modify that opinion except perhaps to make it higher than it was. He doesn't really fit in well with the conventional idea that a scientist, and particularly a scientist who is absorbed in the kind of fundamental questions that he is, is a cloistered type of highbrow who is unable to enjoy the good things of life and unfitted for participation in the world's work. As to the former—his ability to enjoy the good things of life—I could bring forward the testimony of his very large number of friends. As to the other—his capacity to take effective part in the world's work—that is well known.

Indeed he is in the proper sense of the word devoted to science and in particular to a study of the simplest terms in which we may express the multiplicity of chemical phenomena. And he works because he is possessed of an absorbing curiosity to know just what is what, possessed of a desire to correlate things apparently diverse, and from such correlation to be in position to predict new things. With this perhaps goes the fact that his papers are models of concise exposition—so concise indeed that many readers, I believe, fail to grasp their true significance or to see that some remark of his may have implied a very great deal of work and thought in order to be able to make it at all. And with this perhaps also goes the further fact that he is less interested in questions of credit and priority than that we should reach a satisfactory and thoroughly consistent explanation of the phenomena.

Publications

I have left myself little time in which to say anything specific about Mr. Lewis' other lines of work. On looking over the list of his published papers I find that the great majority of them were either about thermodynamics directly or so closely related to it that I felt I should leave them to Mr. Lamb. The others, though, are no less important. There are the papers on the theory of relativity, published ten years ago, to which Mr. Lamb alluded, which were written at a time when that theory had not attracted the attention now drawn to it. And there is one which brings in the subject of vector analysis, which Lewis taught himself in order to be able to attack the problem as he thought it should be attacked. Related to this are later papers on the quantum theory and on a system of ultimate rational units—e.g., to take the speed of light as the rational unit of velocity, and the charge in the electron as the unit of electricity.

Valence Theory

His work which is now probably most familiar to you is that on valence theory. His first paper on this general topic appeared in the *Journal* of our Society in 1913. In it he emphasized the distinction between what he called polar and non-polar compounds, this distinction being roughly the same as that between inorganic and organic compounds, the polar compound being typified by a salt such as sodium chloride, NaCl, the non-polar by a substance such as methane. And he pointed out that these differences may be regarded as depending upon the magnitude of the constraints with which the valence electrons are held. Of course it would take too long to go further into that here, and probably you are all familiar enough with it, so that it would be beside the point for me to go into it.

In 1916 his next paper on the valence theory appeared. That was called "The Atom and the Molecule." In this paper he proceeds to extend this idea expressed in the previous paper and outlines the theory of the

cubical atom, the basic figures to which, it may be noted incidentally, are taken from a memorandum dating from 1902, which is therefore fourteen years before this particular theory was published in the *Journal*. He has since published two other papers dealing with this theory which are less well known, both published in 1917 (one in *Science*, the other in the *Proceedings* of the National Academy), and then in 1917 the war came on, and for a couple of years he was away from all writing of theories. The brilliant advocacy of these ideas by Langmuir and his exemplification and extension of their utility has made them familiar to all who take a real interest in our subject.

Presentation

BY JOHN E. TEEPLE

We come now to the presentation of the Medal itself. This has a significance more than we are accustomed to attach to such ceremonies. To the chemist working steadily and systematically, sometimes brilliantly, to advance his science, no appreciation is so welcome as that of his fellow chemists, men who understand what he is doing, what difficulties he encounters, what patience, skill, perserverance and calm analysis are necessary to surmount them and what bearing his work has on the progress of the science as a whole. On the other hand, the judgment of his co-workers regarding a fellow chemist does not go far wrong. Sometimes in a burst of enthusiasm the jury may pin a medal on a man whose work more mature deliberation may indicate to be not quite up to the proper standard. Sometimes, due to lack of knowledge of the man or interest in the subject, exceedingly high-grade work may be overlooked by a jury. Geniuses, as a rule, are not appreciated until a later generation, but in the long run the judgment of a man's co-workers is just, and an examination of the list of the recipients of the Nichols Medal to date shows a roll of honor. I feel that the jury, in selecting Dr. Lewis for the Medal tonight, have done themselves credit.

Dr. Gilbert Newton Lewis, on behalf of the New York Section of the American Chemical Society, it gives me great pleasure to present to you this beautiful William H. Nichols Medal for your original work on "The Third Law of Thermodynamics and the Entropy of Solutions and of Liquids," and I want to congratulate you personally and on behalf of the Society on this honor that has been conferred upon you.

Color and Chemical Constitution

BY GILBERT N. LEWIS

The science of color may be investigated from several points of view and presents different aspects to the physicist, to the physiologist or experimental psychologist, and to the chemist. The physicist is interested primarily in the properties of light while it is in transit, or, as we used to say before the luminous ether became unfashionable, the physicist is interested in the properties of the various types of ether waves. Frequently the phenomenon of light is compared with the phenomenon of sound, and the analogy is correct in this one respect, that both phenomena are characterized by oscillation or vibration or undulation—that is, with some sort of process of repetition, the period or the frequency of which manifests itself to our auditory or visual senses. Aside from differences of intensity, variations in this frequency are responsible for the variety of the sensations produced through the ear and through the eye. It is this analogy which permits us to transfer the nomenclature of one phenomenon to the other. Thus we sometimes hear people speak of the *tone* of a color.

But while light and sound have in common this property of periodicity, there the resemblance ceases. Sound is produced in air or other material medium by the vibration of a body such as a tuning fork or a violin string, and the vibrations which are audible lie between the range of about 20 per second on the one hand and about 40,000 per second on the other—a range of about ten octaves. On the other hand, the general radiant energy of which light is a portion is produced only by the vibration of a body which is electrically charged. It travels through space even in the absence of any material medium, and that part of the whole gamut of radiant energy which is visible to the eye represents an enormous vibratory frequency—more than a million million oscillations per second.

THE VISIBLE ZONE OF RADIANT ENERGY

The sound produced by a drum differs from the purer tone of a more highly developed musical instrument in that it emits a jumble of many such tones simultaneously, and such a jumble of tones we call a noise. Like such a noise ordinary light is a mixture, representing vibrations of a great variety of frequencies. By means of a prism it is possible to analyze white light into its component tones, and thus we obtain the spectrum, where at every point there is a definite spectral color corresponding to a perfectly definite frequency. The rays that the eye cannot perceive may be seen by the camera and other devices which have made it possible to extend the spectrum and to study radiant energy beyond the limits of visible frequency, and thus investigate the ultra-red on the one side and the ultra-violet on the other. Indeed we now know that all the phenomena of radiant energy, beginning with the low frequencies of wireless telegraphy through the ultra-red into the visible out into the invisible ultra-violet, and from there on out to the region of X-rays, we are dealing with a single phenomenon, varying only in rate of vibration, the rates of which are as follows: Lowest Rubens, 10^{12}; red, 4×10^{14}; violet, $7\frac{1}{2} \times 10^{14}$; farthest ultra-violet, 10^{16}; soft X-rays, 10^{17}, and hardest X-rays, 10^{19}. We see then that of this vast keyboard of radiant energy less than one octave produces visual sensations.

COLOR ABSORPTION

Now the question arises as to what is the source of chemical absorption of light. What is the mechanism? Here is where I will begin to get into trouble. It is evident in the first place that some elements are naturally colored. They are just born that way. Copper in its various compounds, except in a few of the cuprous, is generally colored, although you never can tell what color it is going to display. Many of the salts of the heavier metals are colored, and in those cases it is pretty easy to recognize that the element itself carries within it the color-absorbing mechanism. On the other hand, there are many cases, as you know, of elements which are not ordinary color producers, such as carbon, oxygen, hydrogen, nitrogen, and yet from these may be produced colored substances like nitrogen dioxide, where you have a highly colored substance produced from elements which do not normally give it. Then of course we have the great host of dyestuffs which likewise are made up of elements which do not

normally produce color compounds. It seems to me equally evident that in this case it is not in the atom but in the association of atoms of a particular type that we get the light-absorbing mechanism. Let me as a simple illustration show a few experiments of a primitive character. Here are three copper salts dissolved in alcohol. As you see, although possessing the same amount of copper, they not only have different intensity of absorption, but entirely different color. The cupric nitrate in alcohol has almost the same color which it has in water, rather faint. You will notice the typical blue color of copper salt. The cupric chloride in alcohol has a green color, but nevertheless when poured into the water gives once more the same cupric faint blue appearance. Here is cupric bromide, which you can hardly see through at all. It is a very dark brown in daylight, and yet it contains the same concentration of copper. The copper is always active in forming the color. If we should add to any one of the aqueous copper solutions a small amount of ammonium hydroxide you would get once more a very intense blue color. While we do not know the mechanism in this case, nor perhaps precisely in any other, yet we know pretty much what goes on in these solutions. When copper salts are dissolved in water we do not have the simple arrangement which we usually write as Cu cations and Cl, NO_3, etc., anions.

The Group Color Effect

The work of numerous investigators has shown that in such cases as these we have unquestionably about the central positive ion a group of molecules or radicals which are held with much firmness in this co-ordination sphere which surrounds them. That cupric ion in water is really a cupric ion with four water molecules very firmly attached to it. They can, however, be driven out by ammonia, and ammonia does drive them out and produces cuprammonium, where we know much more definitely than we do in the other case that we have four molecules of ammonia attached to each one of copper. It is evident then, it seems to me, that in this case the copper atom contains within itself the absorbing mechanism, but that mechanism is affected more or less in its action by associated groups, thus changing the intensity and the frequency of the absorbed light, the light absorbed by its environment. Thus copper attached to four ammonia molecules does not produce just the same effect as copper attached to four water molecules, but it does a surprisingly similar thing. They both cut light out of the radiant energy system in the spectrum zone which we call visible light. Any two color substances are very closely akin. Whether they absorb in the violet or the yellow they are not far apart in their properties.

This problem of finding the source of the color-absorbing mechanism is not an easy one. In one case where I can show you a change of color due simply to a change of temperature we know exactly and quantitatively to what that change is due. In the mixture of two gases, NO_2 and N_2O_4, you will see as I heat this up that the upper part of the chamber becomes quite a good deal browner than the lower part. We can calculate quantitatively the relative amounts of N_2O_4 and NO_2. NO_2 is colored and N_2O_4 is colorless. NO_2 is formed at high temperatures, N_2O_4 at low temperatures.

A solution of cobaltous chloride in aqueous solution, with a small amount of acid added while hot, is very deep blue. If, however, it is cooled by being poured into ice the color change is so absolute as to be the opposite of that which we had before; it goes from a bright blue to a bright red. The effect is partly due to the hydration by the ice, although the same experiment can be tried in other ways. This was the simplest way to show the experiment. But we see pretty clearly that there the phenomenon is due to a greater or less degree of hydration, probably a greater or less degree of driving out of the chloride ion from a complex by water. In the diluted aqueous solution this color of the cobaltic salt is characteristic. The hydration is diminished by increasing temperature, diminished by increasing concentration.

Chromophores

It is evident that the absorption of light in the visible spectrum is only part of a larger phenomenon which should be studied in its entirety if we are to obtain the fullest evidence as to the origin of color. Indeed, numerous investigations have shown that many substances which have no power of absorption in visible regions have pronounced absorption bands, as they are called, in the ultra-red, and especially in the ultra-violet. If then through some change in condition a colored substance changes to a colorless substance, as phenolphthalein does on the addition of an acid, it may be that the absorption band has simply ceased to exist, or it may be that the region of absorption has shifted slightly so as to bring it out of the range of the visible. If instead of being able to see less than one octave of the spectrum we could perceive several octaves of light as we do several octaves of sound, most substances would be colored, but those substances which absorbed in the neighborhood of the visible would be found to contain the same types of fundamental color groups or arrangements of atoms which occur in our dyestuffs and which Witt has called chromophores, groups which under a somewhat different environment, or attached to other chemical radicals, might cause visible color.

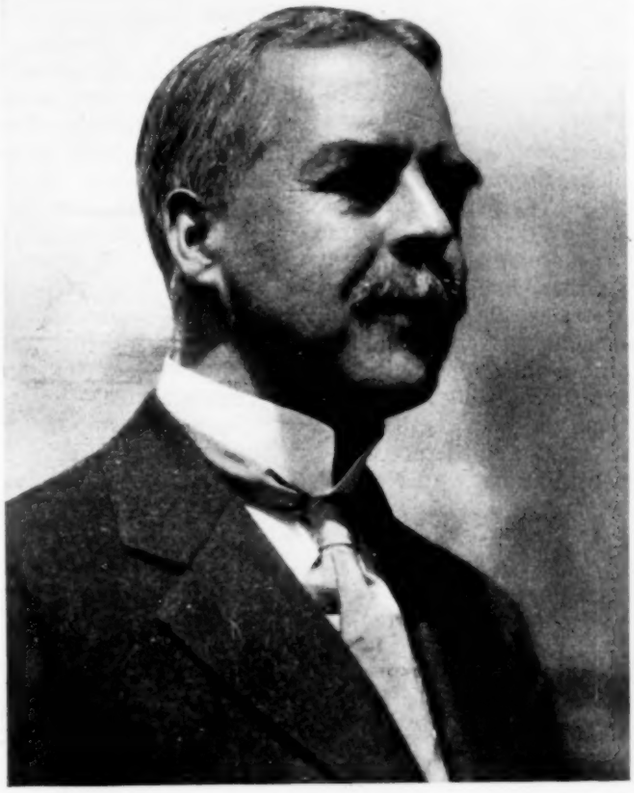
As in the case of indicators, it has been observed that most organic dyes are capable of existing in two or more forms in which the same atoms are in a different arrangement. Such arrangements, which pass over one to the other with such rapidity that it is rarely possible to isolate the separate substances corresponding to the different atomic arrangements, are known as tautomers, and numerous attempts have been made to show that the process of light absorption is due to the vibration of the atoms between two such arrangements in some sort of resonance with the vibration of light itself. These attempts, however, have failed, and indeed it will become evident that they were doomed to failure when we analyze now the exact nature of the process which must be responsible for the absorption of light.

Electronic Vibration

Let us for a moment forget the complicated facts regarding color absorption, of which I have been able to show only a few of the thousands which have been observed, and consider *a priori* what conditions must prevail in absorbing media. We may return once more to the analogous and more familiar phenomena of sound. If we hear a rattling sound in some piece of machinery we at once conclude that there is some loose part which is taking up a part of the energy of the machine and dissipating it by sound waves and by friction. Again, anyone who has played the piano has had the experience of finding some one note which appears harsh and unpleasant, and has discovered that

the fault is not in the piano itself, but in some piece of bric-a-brac in the same room which is set ajar by that one note and no other. This article, whatever it may be, has happened to be so placed as to determine a period of oscillation identical with one of the notes of the piano. It is said to be in resonance with that note, and the energy of sound of that particular pitch is absorbed by it. So a group of tuning forks of a certain frequency would absorb and act as a shield against sounds of that frequency, while notes of another pitch would pass through unchanged.

When we consider the factors that determine the natural frequency of vibration of such oscillator we find two that are of prime importance. The pitch of a violin string depends upon how tightly the string is keyed up; the tighter it is the higher the pitch or the frequency of vibration. But also the weight of the string is important. Thus while the E string is light and tense, the G string is not only left slack, but it is wound about with metallic wire to give it a greater mass. The greater the mass the lower the frequency of vibration.



GILBERT NEWTON LEWIS

These ideas are directly transferable from acoustical to optical phenomena, where, however, the resonators must now be electrically charged, and must possess an enormously high vibration frequency. In the molecules there are two sets of charged particles capable of acting as such oscillators. On the one hand the positively charged nuclei of the atoms, which have a mass approximately equal to that of the atom itself, and on the other hand the negatively charged electron with a mass more than a thousand times smaller. On account of the relatively high mass of the positive particles it seems probable that they never, or almost never, are capable of vibrating with a frequency sufficiently high to come within the scope of the visible spectrum, but rather cause absorption in the ultra-red. On the other hand, those light and indeed almost massless particles which we call electrons are usually held tightly enough so that their natural period is well above that of the visible spectrum, and they can therefore absorb light only in the ultra-violet region. Thus in the great majority of chemical compounds which are colorless the positive parts have too low a frequency and the negative parts too high a frequency to affect the visible spectrum. If, however, the constraints under which these electrons are held are in some way loosened their frequency of vibration will diminish, and ultimately they may become so loosely held as to absorb in the visible.

I once greatly perturbed one of our candidates for a doctor's degree who was coming up for his examination in organic chemistry by asking him why it was that when most organic substances were heated up they turned yellow. He didn't think that was a fair question. But it seems to me it is a rather interesting question. Why is it that when organic substances are heated up they turn yellow? Why don't they turn green or violet or indigo? If you will remember the spectrum with the red at one end, the violet at the other and beyond that the great range of the ultra-violet—supposing that you consider a substance in which the electrons are loosely held, but not quite loosely enough to get into the visible, it will be absorbing just in the ultra-violet region. Supposing that you make some minor change, perhaps a polarization of molecules, or some similar change in the organic molecules which will lower slightly the absorption period. Then that will shift down into the visible. The first thing it strikes will be the violet. Taking out the violet leaves a preponderance of yellow, the complementary color which is found in general in the decomposition of all organic substances.

Let us then examine more intimately into the structure of the molecule in order to ascertain, if we may, what relation it bears to the tightness of the constraints which we may conceive to be operating upon the individual electrons. The wonderful development of organic chemistry, which is the chemistry of the carbon compounds, has been due in great measure to the introduction of the so-called structural formula.

The theory of the combination of atoms and the structure of the atom, which I published a few years ago, can hardly be used to predict the phenomena of color, as it was to a large extent derived from the phenomena of color. The color absorption was one of half a dozen of the leading methods by which we were able to attack the problem of the internal structure of the molecule and the atom. I might mention one more experiment. The substance NO_2 is colored brown, although when it polymerizes to N_2O_4 it is not colored.

There is an organic substance which I want to speak about which is similar, being water white, though a little opaque due to turbulence. It is a solution of triphenyl methyl chloride in benzene. Most of you are familiar with the method by which Gomberg succeeded in obtaining a free radical from this solution by simply adding zinc dust. The zinc combines with the chlorine, leaving the radical triphenyl methyl free, which forms about the zinc in a brown film. That color is not particularly striking, but it is a very peculiar colored substance, belonging to the same class as NO_2, and I shall have occasion in a moment to speak of both of them

again. Just to run very hastily over the points involved here, it seemed to me, from the facts of the periodic table alone, that there was a very strong tendency on the part of atoms and molecules to conform to certain very simple types, and to a very small number of types. By a study of the periodic table several investigators were led independently to the idea of a structure of certain atoms, much as I have stated here.

Arrangement of Nucleus and Electrons in the Atom

The first one represents by its cross the nucleus of a helium atom, and by the two points, the two electrons which just balance the charge (Fig. 1).

The next one is the neon atom, where we have once

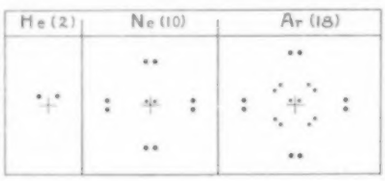


FIG. 1. HELIUM, NEON AND ARGON

more the two electrons in the center, but outside of that this group of eight which Langmuir has called the octet, this group of eight electrons which surround the central group. In the old days I used to speak of this as the cubic theory of the atom, but when my paper appeared I had already rather changed from the idea of cubic to the idea of tetrahedral. The figures are usually made in three dimensions, but let us imagine each of these atoms has a center with four pairs of electrons fairly close together, surrounding in tetrahedral form this central portion, and here in the case of argon with an atom number of 18 and therefore requiring 18 atoms to make a neutral atom, we have one

FIG. 2. HYDROFLUORIC ACID AND NEON

of these tetrahedrons composed of four of these electron pairs, and then outside of that another.

These rare gases are not the only ones. These are very simple configurations. Indeed, if I should put on the screen the fluoride ion or the oxide ion they would look exactly like that middle ion picture, and if I put the chloride ion on the screen it would look exactly like the argon picture (Fig. 1). If I put potassium on the screen it would look just like the argon picture. There are certain few types to which these elements belong. They may form these types by forming ions—that is, by lending or gaining enough electrons to form somewhat rudimentary types—and they may form these by another manner, and this, to the chemist, is the essential feature of that theory which I was fortunate enough to work out just before the war: the new theory of the chemical bond.

The Electron Bond

An electron passing from one atom to another and thus in some way bringing about a chemical reaction goes way back to the Faraday lecture of Helmholtz. But that represents only a small part of what we may call the function of the electron in chemical change. Fluorine, which is represented by the neutral atom, would have one fewer electron and therefore does not represent the group of eight, can take on that additional electron to make this very considerable configuration which we have here, not by taking that electron away from another atom but by bringing the atom along too. And by that cross over on the left (Fig. 2) I have represented the nucleus of the hydrogen atom, which instead of parting with its electron goes along and together with the fluorine produces this neutral group of eight electrons in the outer shell. So you see by taking on hydrogen you get once more this formation which is characteristic of so many compounds and which is represented by neon. In other words, that pair of electrons held between two atomic centers is the very thing which we have been looking for under the name of the chemical bond.

There is no question that organic chemists have always had a feeling within themselves that this bond between carbon and hydrogen was not a mere product of the imagination but was a real entity, was a real physical thing, and here I believe we may state just what that bond is. It is that pair of electrons which joins two atoms. Here, for example, we have almost precisely the same configurations. Only carbon has to

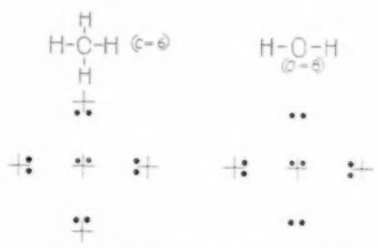


FIG. 3. METHANE AND WATER

take on four hydrogens, having four less electrons itself, and oxygen has to take on two hydrogens to make water, which has the same configuration (Fig. 3).

The Bonds in the Halogen Group

Then in addition to the bond between these atoms and hydrogen—hydrogen is a very unusual type of atom—we can see how two of these groups holding one pair in common are able to satisfy their complete groups of eight. It is these two figures, and one or two following, which I want to call attention to particularly, because there it seems to me that we have one of the few cases where we know almost precisely what the absorbing mechanism is in colored substances.

You see these figures all look much alike. No matter what formula they are attached to, there are only a few types altogether. This large group in Fig. 4 is fluorine, F_2. Fig. 5 shows methyl fluoride. The only difference is that it has three hydrogen atoms and different nuclei, of course. The bond, that pair of electrons which is holding together the repellent positive particles, may be a tight bond or it may be a loose bond. It is a tight bond in both of these gases.

Chlorine has a similar structure to the fluorine molecule, except that it has in addition an exterior shell over that which we see in the fluorine molecule. As these two atoms get heavier and heavier the pull on

that central bond becomes greater, and in bromine it is greater than it is in chlorine, and in iodine it is greater than it is in bromine, and we know that iodine vapor at quite a moderate temperature decomposes into two atoms of iodine. Unlike the case where we have a decomposition substance produced, the break is right here between these two electrons, one going to the

FIG. 4. FLUORINE

one and one to the other; we get that peculiar case of which only a handful of instances are known, of the hundreds of thousands of chemical substances, where you have a molecule with an odd number of electrons, and whenever you get a molecule with an odd number of electrons you get color. There is only one known case, that is NO, of one of these substances with an odd number of electrons that are called the odd molecules which do not absorb light. In other words, they are substances one of whose electrons at least is held by so loose a constraint as to absorb light in the visible region. It is the bond electron that is active. I don't know whether it stays in the location shown or not, when the molecule breaks apart, because these molecules are peculiar things; but no matter where it goes, you have always an odd number. And that electron is held by much weaker constraints than all others. You remember when the two odd molecules came together by a bond forming N_2O_4 the thing became colorless. That is not the case with iodine atoms, and in fact we must now pass to the case of the odd molecules themselves.

This, by the way, is the type of all the organic molecules of which none were known a few years ago and which since Gomber's discovery have been increased by dozens, both for carbon and hydrogen compounds. It is not necessary always for this bond to break before these electrons begin to be loosely held; and so iodine

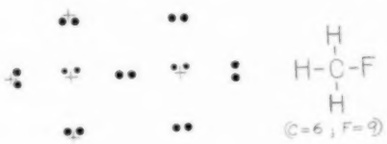


FIG. 5. METHYL FLUORIDE

which is almost broken shows a gray color in the vapor phase of I_2. Bromine shows less. Chlorine shows less. Fluorine, as you know, is almost colorless; and there, by every evidence we have, that bond is a tight one. Think, in spite of its tremendous affinity, how relatively inert a substance like chlorine is, compared to a substance like iodine.

Organic Bonds

The typical bond of organic chemistry is shown in Fig. 3 with methane—a tight bond in which the electrons are held with such firmness that they don't absorb light in the visible and they don't absorb light in the ultra-violet, as far as it is possible to investigate that substance.

Ethylene, Fig. 7, is a typical unsaturated organic substance, in which the bond pair of electrons are in the position which is one of greatest stability—the pair of electrons held exactly between two central positive atoms. It is impossible for the double bond, where you have two electron pairs taking part simultaneously, to be in the middle of a line exactly joining these centers. They are crowded apart, and not only our evidence from color but our evidence from chemical reaction and the great variety of other evidence we have shows that the electrons in double bond are held much more loosely. And you will find that of all the color compounds of

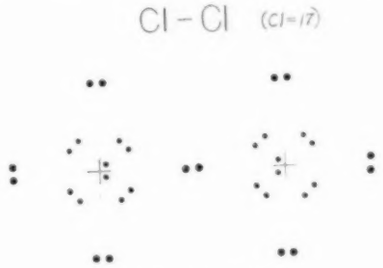


FIG. 6. CHLORINE

organic chemistry except these rare ones which have the odd electron every one contains a double bond, and most of them are composed very largely of radicals with double bonds. That double bond is not ordinarily

FIG. 7. ETHYLENE

sufficient. The electrons, although much less firmly held than in the single bond, are not ordinarily loosely enough held to produce absorption of visible light. Their vibration frequency is in the ultra-violet, but by adding to the unsaturation of these molecules, by doing the various things which the organic chemist will tell you will loosen that bond, even if he hasn't any interest in the problem of color at all, you will find that these enter into the domain of the dyes.

Quantum Theory Will Not Alter Present Color Theory

I do not wish to make this problem of color seem more simple than it really is. It will be long before we reach any complete understanding of the thousands of detailed observations which have been made in this field, and we do not know as yet how far our ideas will have to be modified by that great wave of bolshevism in physics which is known as quantum theory. Einstein, perhaps the profoundest thinker in physical science that this century has known or will know, and whose name has recently become almost a household word through the offices of the daily and the comic press, was one of the first exponents of quantum theory. But, as he once said to me in conversation, "Quantum theory is not yet a theory in itself, it is simply a negation of the older theories." It seems, however, that in the region of loosely bound electrons which characterize our colored substances the further development of the quantum theory will not greatly modify such conclusions as we have discussed today.

A Study of the Saturated and Unsaturated Oils From Shale

An Investigation of the Amount and Causes of Unsaturates in Shale Oils—Cracking During Retorting and Distillation Accompanied by an Increase in Saturation—Unsaturates Vary With Nature of Shale and Methods of Pyrolysis

By C. W. BOTKIN
Research Chemist for the American Shale & Petroleum Co.

WHEN distillates from our shale oils are treated with an excess of sulphuric acid, there is a large loss of oil. This indicates a high percentage of unsaturated compounds and considerable refining loss if the oil is to be refined by the usual acid treatment. Both the refining methods and the utilization of shale oil depend to a large extent on the quantity and nature of the saturated and unsaturated constituents. Hence it is highly desirable to know the percentage and distribution of saturates and unsaturates, the factors which tend to increase the former and diminish the latter, and any physical or chemical properties of the unsaturated compounds which may aid in indicating proper methods of retorting and refining or in suggesting uses for the oil. Most of the experimental work of this paper was done to obtain information for practical purposes and while no attempt has been made to study a large number of oils or to make an exhaustive study of shale oil hydrocarbons, it is hoped that some valuable information has been obtained concerning the extent of their saturation, the cause of the unsaturates, the distribution of the saturates, the effect of cracking on saturation, and some of the properties of the unsaturated substances.

The Determination of Saturates and Unsaturates

In all determinations the oil has been treated with two volumes of sulphuric acid (c.p., dens. 1.84) and the volume of the oil remaining expressed in percentage of the original volume is the percentage of saturated compounds. The difference between this and 100 is the percentage of unsaturated compounds. Some chemists may question the propriety of the term "unsaturated" to designate these substances and also the use of sulphuric acid as a means of measuring the amount of unsaturated compounds, since in addition to combining with unsaturated bodies, water and other substances are dissolved by the acid, basic constituents are neutralized, polymerization may occur and some aromatic compounds may be absorbed.[1] However, this method is apparently satisfactory for practical purposes when used on shale oils and is considered sufficient for the experimental work of this paper. The method[2] used is as follows: Five or 10 c.c. of the oil is measured into a 9- or 18-g. 50 per cent Babcock cream-test bottle and a double volume of the acid added. The bottle is kept cool by immersion in cold water but is shaken gently at intervals until finally with vigorous shaking there is no longer a rise in temperature. Then the bottle is filled to the neck with acid and centrifuged at 1,000 r.p.m. for three minutes. The oil remaining is now brought into the graduated neck of the bottle by addition of more acid and the centrifuging is repeated. The percentage of saturates is calculated from the volumes of the remaining oil and the original oil. When the acid concentration is constant, the results check within 0.5 per cent. A correction is made whenever the water content of the oil exceeds this value. When the oil is solid, it is warmed enough to keep it in the liquid condition.

[1] Technical Paper 181, U. S. Bureau of Mines, p. 11.
[2] Modified from Egloff, Gustav, and Twomey, Met. & Chem. Eng., March, 1916, p. 247, and Technical Paper 181, U. S. Bureau of Mines, p. 11.

Results of Determinations

Using this method, saturation tests have been made on shale oils from Colorado, Wyoming, Utah, Nevada, Quebec, England and Scotland. The oils tested include crude oils produced by twelve different plant processes of retorting and crude oils obtained from eleven different shales in laboratory retorts. Most of the plants were in an experimental stage. The laboratory retort was of the usual iron, "mercury-distillation" type operating without steam. The results obtained by these determinations are given in Table I. The saturates in the oils tested very between 12 and 41 per cent. This indicates a high percentage of unsaturated compounds in the crude oils from all of the above sources and methods of retorting.

TABLE I

Oil by Plant Retort			Oil by Laboratory Retort		
Shale	Plant No.	Saturates, Per Cent	Shale	Laboratory No.	Saturates per Cent
Colorado	1	17.5	Colorado	1	14.0
Colorado	2	11.6	Colorado	2	22.0
Colorado	3	28.0	Colorado	3	17.0
Colorado	4	15.5	Colorado	4	12.8
Colorado	5	13.6	Colorado	5	19.7
Colorado	6	15.5	Wyoming	6	15.5
Colorado	7	16.0	Wyoming	7	17.8
Utah	4	15.8	Wyoming	8	20.0
Utah	8	26.5	Wyoming	9	16.3
Utah	9	16.0	Wyoming	10	12.4
Nevada	10	41.2	Quebec	11	12.0
England	11	16.0			
Scotland	12	38.0			

Causes of the High Percentages of Unsaturates —Low Content of Hydrogen

One explanation of this high percentage of unsaturates in shale oils is that the kerogen or oil-yielding material of the shale does not contain sufficient hydrogen to produce saturated compounds with a large portion of the carbon in the hydrocarbons volatilizing during the destructive distillation of the shale. This is indicated by the fact that free carbon is present in all spent shales and by the results of chemical analyses of the kerogen or shale. Analyses of the kerogen from Scottish shales reported by Mills[3] show a hydrogen to carbon ratio of about 1 to 6.9. Robertson states[4]

[3] *J. Inst. Pet. Tech.*, 1916, p. 238.
[4] *Proc. Roy. Soc. Edinburgh*, vol. 34 (1914), p. 190.

that for Broxburn shale this ratio varies between 1 to 6 and 1 to 8 and over, and that the greater the proportion of hydrogen the larger the yield of oil. An average of six ultimate analyses made on Nevada, Utah and Colorado shales by J. D. Davis of the United States Bureau of Mines[4] gives a ratio of 1 to 7.8. The ratio of hydrogen to carbon is about 1 to 5.6 for the average gravity paraffine hydrocarbon found in mineral oils and is 1 to 6 for an olefine. We would not expect an organic substance such as kerogen, which apparently contains no free carbon and which has a hydrogen to carbon content of 1 to 7, to decompose with the formation of a large percentage of paraffines in which this ratio must be 1 to 5.6 unless considerable free carbon is formed. It is probable that the higher the hydrogen content of the shale the greater will be the percentage of saturates in the oil, and it is evident that cracking would tend to increase the saturation of the oil if the hydrogen content of the permanent gas and coke is much less than one-seventh of the carbon content. In other words, it is possible that the smaller the yield of oil from a given shale which is completely carbonized the higher may be the percentage of saturates in the oil. While the above data are not sufficient for far-reaching conclusions, they indicate that there is not enough hydrogen in the organic material found in shales to produce saturated compounds with all of the carbon, and consequently for a maximum yield of oil it must be highly unsaturated.

Cracking of the Oil

Some of the inventors of shale retorts in this country have suggested another explanation for the high percentage of unsaturates. It is generally known that the overheating of petroleum oils causes a decomposition or cracking of the oil and that this cracking at atmospheric pressure is accompanied by an increase in the percentage of unsaturated compounds. Using this as a premise, they conclude that the high temperature used in the destructive distillation of the shale cracks the oil and produces the unsaturates. Acting on this principle, retorting processes have been planned to operate at a minimum temperature, thereby preventing cracking and thus producing a more saturated crude oil. Some advocate steam-retorting as a preventive of cracking and claim to obtain a more highly saturated product in this way.[6] Redwood states[7] that in Scottish practice retorting with steam prevents the formation of olefines. Others claim that the beneficial effects of low-temperature carbonization of coal on the distillates applies also to shale. However, the writer has not been able to find any published data to prove that the cracking of shale oil tends to increase the unsaturates or that more saturates are obtained when the retorting is done at low temperatures or with steam. In November, 1919, G. W. Wallace[8] reported that he had found that shale oils crack more readily than petroleum oils and that a large amount cracking occurred during distillations at atmospheric pressure. In January of last year the writer began a study of the extent of this cracking and found that the oils tested cracked to an unusual degree when distilled at atmospheric pressure and were also unusual in that the oil after distillation contained a much larger amount of saturated compounds than the original crude oil.[9] This unexpected increase in saturation, produced apparently by cracking of the oil, indicated that the high percentage of unsaturates might in part be due to low-temperature carbonization, which, while serving as a preventive of decomposition as intended, acted also at cross-purposes and produced an oil lower in saturates.

Experiments in Shale Retorting

The influence of low- and high-temperature retorting on saturation and the effect of the presence of steam and hydrogen gas during retorting were studied by distilling samples of a Colorado shale in a laboratory retort under four different conditions. In the first two distillations the oil was removed at as low a temperature as possible without steam; in the third and fourth distillations the oil was removed at as low a temperature as possible introducing steam at the base of the retort; in the fifth and sixth distillations the oil was removed at a low temperature introducing hydrogen instead of steam; and in the seventh and eighth distillations the oil was removed by a more rapid application of heat but its rapid escape prevented by an iron, air-cooled, reflux condenser, which returned the heavier oil to the hot shale in the retort. The temperature of the shale was obtained by a 900 deg. F. Tagliabue thermometer inserted in a thermometer-well which reached to a point near the center of the shale. The vapors coming from the retort were passed through a water-cooled vertical condenser and the oil and water condensing were received in a graduated cylinder or a cylindrical trap. The permanent gases were conducted from the receiver through 5 per cent sulphuric acid in a Meyer tube and measured by a wet-test gas meter. At the end of the distillation boiling water was passed through the outer tube of the condenser to melt and remove any oil which had solidified in the inner tube. The oil in the receiver was then measured and after

TABLE II. DATA ON RETORTING

	Without Steam		With Steam	
	No. 1	No. 2	No. 3	No. 4
Oil, gal. per ton	74.6	75.0	78.5	78.2
Permanent gas, with oil, cu.ft. per ton	1,980	2,005	2,620	2,266
Permanent gas, total, cu.ft. per ton	3,436*	3,744†	3,035*	10,530†
Spent shale, lb. per ton	1,187	1,178	1,214	1,050
Fixed carbon and volatile matter in spent shale, per cent by weight	.....	16.8	.....	5.7
Gravity of crude oil	0.887	0.890	0.916	0.910
Saturation of crude oil, per cent	26.2	24.0	15.6	17.6
Temperature when flow of oil started, deg. F.	550	500	420	425
Temperature when oil was one-half off, deg. F.	745	750	740	750
Temperature when oil ceased, deg. F.	800	815	825	800
Final temperature, deg. F.	875	900+	900	900+
Amount of steam used, per cent water is of oil by vol.	.....	.....	520	710
Volume of steam, cu.ft. per ton‡	.....	.....	83,180	115,250

	With Hydrogen		High Temperature	
	No. 5	No. 6	No. 7	No. 8
Oil, gal. per ton	77.2	77.9	69.9	70.0
Permanent gas, with oil, cu.ft. per ton	1,825	1,675	.....	.....
Permanent gas, total, cu.ft. per ton	2,530*	3,060†	2,540*	2,635*
Spent shale, lb. per ton	1,173	1,100	1,223	1,216
Fixed carbon and volatile matter in spent shale, per cent by weight	.....	9.5	.....	18.7
Gravity of crude oil	0.900	0.907	0.874	0.872
Saturation of oil, per cent	20.6	18.6	30.1	30.2
Temperature when flow of oil started, deg. F.	600	585	595	610
Temperature when oil was one-half off, deg. F.	750	745	750	755
Temperature when oil ceased, deg. F.	850	850	885	900
Final temperature, deg. F.	900	900+	900+	900+
Amount of hydrogen used cu.ft. per ton	10,590	16,620	.....	.....

* Heating discontinued soon after the oil flow ceased.
† Heating continued for one hour after the oil flow had ceased.
‡ Calculated for 20 deg. C., 615 mm., the conditions under which the hydrogen was measured.

[4] Bull. 641, U. S. Geological Survey, p. 161.
[5] R. D. George, Railroad Red Book, July 1920, p. 647.
[6] I. I. Redwood, "Treatise on Mineral Oils and Their Byproducts," p. 52.
[7] Inventor of the Wallace retort.

[8] This experimental work is presented in the third division of this paper.

TABLE III. DATA ON FRACTIONATION OF OILS

First Distillation	Without Steam Nos. 1 and 2	With Steam Nos. 3 and 4	With Hydrogen Nos. 5 and 6	High Temp. Nos. 7 and 8
Water, per cent by weight	0.2	0.4	0.35	0.0
Oil, per cent by weight	94.0	86.6	88.6	96.9
Coke, per cent by weight	4.4	10.0	8.8	2.5
Gas, by difference	1.4	2.95	2.25	0.6
Gas, volume in c.c.	1,090	2,430	1,810	310
Gasoline, to 410 deg. F. per cent vol.	20.3	13.6	17.0	29.0
Kerosene, to 575 deg. F., per cent vol.	22.1	20.4	20.9	29.8
Heavy oil, to coke, deg. F. per cent vol.	53.6	57.1	54.0	39.2
Gravity, once-run oil	0.870	0.875	0.871	0.864
Saturation, once-run o.l, per cent	36.4	35.2	36.3	36.0
Increase in gravity	0.0185	0.038	0.0325	0.009
Increase in saturation, per cent	11.3	18.6	16.7	5.9
Increase in volume of saturates, per cent	36.2	83.7	64.3	15.6
Maximum boiling point, deg. F.	707	705	695	700
Second Distillation				
Gasoline to 410 deg. F., per cent	25.4	24.1	24.7	31.7
Cracked oil to 410 deg. F., per cent	5.2	10.5	7.6	2.7

washing with water was kept at 100 to 130 deg. F. in tightly stoppered bottles for three days in order to secure a rather complete separation of water. At the end of this time the volume of the oil was remeasured and samples taken for the saturation tests. The portions of oil obtained under each condition were combined and a fractional distillation made on each. These fractionations were made on 50-c.c. portions in a standard 100-c.c. Engler distilling flask. The coke values were obtained by weighing the flask before and after the distillations. The oil percentage by weight was calculated from the gravity and volume of the oil. The weight-percentage of gas was obtained by difference and its volume was measured by meter. A second distillation of the once-distilled oil was made to 410 deg. F. to determine the increase in this fraction caused by cracking. The results of the retorting experiments are given in Table II and of the fractionations in Table III.

Results of Shale-Retorting Experiments

The most important result shown by the data in Table II is that no one of the four conditions of retorting produced from this shale a crude oil containing over 30 per cent of saturates. This is doubtlessly due to the low hydrogen content of the shale and indicates that the nature of the shale and not the process of retorting is by far the predominating factor in determining the percentage of unsaturates. Where the cracking is minimized by the steam-retorting the unsaturates are about 15 per cent higher than in the retorting with the reflux condenser, where the decomposition is at a maximum. The presence of free hydrogen in the retort does not affect the saturation of the oil, except as it acts similarly to the steam in preventing some of the cracking through speeding up the removal of the oil vapors.

The position of the thermometer and the manner of application of heat to the retort were such that the readings taken when the oil was about half off more nearly indicate the decomposition temperatures of the shale than the other readings. These temperatures are between 740 and 755 deg. F. and are independent of the presence of steam or hydrogen. This temperature is probably somewhat of a constant for a particular shale and like the hydrogen content of the shale is not dependent on the process of retorting. The maximum boiling point of the shale oils (705 deg. F.) is probably lower than the average decomposition temperature of the shale, consequently the longer the oil vapors are subject to the higher temperatures in the retort the greater the tendency to decompose the unstable portions of the oil. The introduction of steam or hydrogen increases the rate of flow of the vapors, thus diminishing the decomposition, and under these conditions there is a somewhat larger yield of oil of higher specific gravity and lower content of saturates. The cracking of the shale oil vapors is apparently a decomposition of unstable unsaturates with the formation of coke, gas and a rather high percentage of saturated lighter oils. Hence if we would increase the saturates in the crude oils by retorting conditions, we must not limit the decomposition to the shale alone but subject the oil vapors to the higher temperatures long enough to secure a decomposition of the unstable, unsaturated compounds.

Table III shows the results of a fractional distillation of the oils obtained under the four different conditions of retorting. The oil obtained with steam, containing 16.6 per cent of saturates, cracked to the greatest extent on distillation, yielding 10 per cent of coke, 2.95 per cent of gas and 86.6 per cent of oil containing 35 per cent of saturates. Where the increase in saturation is less, there is a corresponding decrease in the coke, gas and cracked-gasoline values and there is a less decrease in gravity, all of which would be associated with a smaller amount of decomposition. The once-run oil in all four cases is much the same in gravity and saturation, excepting that the oil retorted by a maximum of cracking (Nos. 7 and 8) is lighter due to a higher content of gasoline and kerosene and has a correspondingly less proportion of heavy oil. The decomposition, which was not completed in the retort, is apparently complete when the crude oil is distilled at atmospheric pressure without steam or other preventives of cracking.

Effect of Distillation of the Oil on Saturates and Unsaturates and Their Distribution

A study was made of the effect of distillations at

TABLE IV. DISTILLATIONS OF CRUDE ASPHALTIC OIL

Oil Percentage-off	Still Temp., Deg. F.	Vapor Temp., Deg. F.	Gas, c.c. per Cut	Gravity of Oil	Saturates, per Cent by Vol.
(*a*) First distillation, sample 800 c.c.				0.939	26.5
I.b.p.*	275	178	...	...	...
10	497	402	25	0.829	48.0
11.25	500	410	...	...	...
20	565	466	40	0.868	40.5
30	630	521	115	0.892	36.0
40	...	590	210	0.910	35.5
50	715	622	310	0.921	35.0
60	746	612	1,190	0.914	34.0
70	766	607	2,020	0.891	40.0
80	795	528	4,035	0.882	46.0
85.5	875	435	2,150	0.892	46.0
(*b*) Second distillation.			Once-run oil	0.888	40.0
I.b.p.	243	155	...	...	...
10	435	350	0	0.785	56.0
19.34	476	410	...	...	...
20	486	419	0	0.838	48.0
30	517	464	0	0.867	44.5
40	550	506	0	0.885	42.5
50	580	546	0	0.899	42.0
60	605	566	0	0.909	40.0
70	...	604	0	0.917	39.0
80	...	646	0	0.927	36.5
90	775	730	0	0.934	30.0
98.9	885	700	1,050	0.940	26.0
(*c*) Third distillation.			Twice-run oil	0.889	40.4
I.b.p.	238	152	...	...	...
10	445	370	0	0.788	55.0
19.84	488	410	...	...	...
20	492	411	0	0.839	47.0
30	526	464	0	0.865	44.0
40	556	484	0	0.881	41.0
50	572	546	0	0.897	40.5
60	619	582	0	0.909	40.0
70	...	620	0	0.915	39.0
80	685	658	0	0.926	38.0
90	780	726	0	0.935	35.5
99.8	896	700	700	0.937	34.4
Thrice-run oil				0.890	41.0

(*d*) Products of distillations in percentage by weight.

	Crude Oil	Once-Run Oil	Twice-Run Oil
Water	0.2	0.22	0.2
Oil	80.9	98.76	98.71
Coke	16.5	0.77	0.9
Gas (by difference)	2.4	0.25	0.19

* Initial boiling point.

TABLE V. DISTILLATIONS OF PARAFFINE-BASE SHALE OIL

Oil Percentage-off	Still Temp., Deg. F.	Vapor Temp., Deg. F.	Gas, c.c. per Cut	Gravity of Oil	Saturates, per Cent by Vol.
(*a*) First distillation, 800 c.c. crude oil				0.877	41.2
I.b.p.	314	224	....	.....	....
3.8	493	410	....	.....	....
10	532	467	0	0.836	60.0
20	580	508	0	0.844	59.0
30	620	585	80	0.853	58.6
40	662	606	140	0.856	59.6
50	690	643	420	0.854	60.2
60	725	657	980	0.853	60.5
70	755	670	1,400	0.851	61.0
80	780	705	1,820	0.845	58.0
90	802	705	5,460	0.844	56.0
97.3	804	625	1,455	0.922	32.5
(*b*) Second distillation, once-run oil				0.851	58.8
I.b.p.	280	205	....	.....	....
7.2	476	410	....	.....	....
10	492	432	0	0.795	60.8
20	530	486	0	0.836	60.7
30	565	524	0	0.844	60.5
40	592	550	0	0.851	60.4
50	623	578	0	0.854	60.4
60	647	613	0	0.857	60.3
70	680	650	0	0.859	59.8
80	709	675	70	0.865	58.8
90	737	700	240	0.867	53.8
99.5	840	715	1,590	0.873	47.8
(*c*) Third distillation, twice-run oil				0.849	58.5
I.b.p.	268	196	....	.....	....
8.8	476	410	....	.....	....
10	485	425	0	0.791	61.2
20	521	475	0	0.833	61.0
30	552	514	0	0.843	60.8
40	581	542	0	0.848	60.5
50	605	570	0	0.853	60.4
60	629	600	0	0.855	60.3
70	659	635	0	0.860	60.3
80	693	665	0	0.863	60.2
90	735	708	70	0.866	59.2
99.5	843	718	880	0.871	40.4
Thrice-run oil				0.848	58.6

(*d*) Products of Distillations in Percentage by Weight:

	Crude Oil	Once-Run Oil	Twice-Run Oil
Water	0.1	0.0	0.0
Oil	95.0	99.16	99.5
Coke	3.4	0.59	0.35
Gas (by difference)	1.5	0.25	0.15

atmospheric pressure on the cracking of shale oils and on the amount and distribution of the saturates and unsaturates. The results obtained with three different types of oils will be given somewhat in detail. These oils include an asphaltic oil from a Utah shale, an oil rich in paraffine from a Nevada shale and an oil of mixed-base variety from a Colorado shale. The samples for distillation were taken from 5-gal. cans which were originally filled from batches of oil obtained in quantity from shales representative of those being worked at three different places in the states mentioned. An 800-c.c. portion of each of the oils was distilled at atmospheric pressure (24.2 in. in Golden, Col.) from a 1,000-c.c. pyrex distilling flask. The vapors were condensed in a vertical water-cooled condenser ending in a trap from which any permanent gas formed by cracking was conducted through a wet-test gas meter and measured. The oil from the trap was removed at such intervals as to obtain 10 per cent fractions, and when each fraction was complete a reading was taken of the still temperature, vapor temperature and the amount of gas formed. The gravity of each cut was determined by hydrometer and after removing a sample for a saturation test the remainder was composited and is designated as once-run oil.

After determining the gravity and saturation of the once-run oil a portion (580 or 600 c.c.)[10] was distilled a second time from a similar flask and the same kinds of data taken as in the first distillation. The twice-run oil thus obtained was then composited as before and a third distillation made (except with the mixed-base oil) in the same manner, recording similar kinds of data. The percentages of coke were determined by weighing the empty flask before the distillation and the flask with contents after the distillation. The temperatures were taken with Tagliabue thermometers. For the vapor temperatures the bulb of the thermometer was in the usual position and for the still temperatures it was placed in the center of the flask about 2 to 3 mm. from the bottom. The data obtained with the asphaltic oil are given in Table IV, with the paraffine base oil in Table V, and with the mixed-base oil in Table VI.

[10]With the mixed-base oil the gasoline to 410 deg. F. was excluded and the second distillation made with 500 c.c. from a composite of the remaining oil.

Results of Distillations of Shale Oils

A study of Tables IV, V and VI will justify the following statements relative to the cracking and the the saturated and unsaturated content of the oil:

(1) There is a large amount of decomposition during the distillation of the crude oil. Measured in percentage of permanent gas and coke formed, it is 4.9 for the paraffine-base oil, 10.2 for the mixed-base oil and 18.9 for the asphaltic oil. It is also manifest by the lowering of the vapor temperature and by a decrease in the specific gravity of the fractions.

(2) The cracking occurs after the still temperatures have reached 600 deg. F. (vapor temperatures 500 deg. F.) and is most rapid when the still temperature is about 800 deg. F.

(3) Compared with the first distillation, the decomposition during the second and third distillations is very slight, occurring only at the higher still temperatures when the distilling flask is nearly dry and probably at a temperature exceeding that indicated by the thermometer. This shows a high stability for the heavy fractions of the once-run oils and indicates that after the first distillation shale oils do not crack more readily than petroleum oils.

(4) The decomposition of the crude oils is accompanied by a considerable increase in the saturation of the oil. This is shown by an increased saturation in the heavier fractions and by a higher saturation value for the once-run oils. The volume of the saturates increased 29.0 per cent for the asphaltic oil, 38.8 per

TABLE VI. DISTILLATIONS OF MIXED-BASE OIL

Oil Percentage-off	Still Temp., Deg. F.	Vapor Temp., Deg. F.	Gas, c.c. per Cut	Gravity of Oil	Saturates, per Cent by Vol.
(*a*) First distillation, 800 c.c. crude oil				0.920	16.0
I.b.p.	248	153	....	.....	....
10	448	346	0	0.783	43.0
15.9	504	410	0	0.826	39.0
25.9	568	482	0	0.861	33.0
35.9	635	540	230	0.888	28.6
45.9	689	588	810	0.908	27.0
55.9	729	615	2,570	0.904	29.0
65.9		660	3,350	0.905	31.5
75.9	810	705	3,400	0.906	31.5
85.9	840	675	6,000	0.909	30.0
92.6	850	625	4,210	0.992	28.7
(*b*) Second distillation, once-run oil*				0.904	30.0
I.b.p.	245	175	....	.....	....
10	464	396	0	0.785	51.0
12.6	476	410	....	.....	....
20	504	462	0	0.855	39.0
30	543	510	0	0.875	37.0
40	578	549	0	0.893	34.2
50	610	578	0	0.905	31.4
60	644	624	0	0.918	30.6
70	680	548	0	0.927	30.0
80	720	680	195	0.932	28.4
90	760	714	520	0.938	27.0
98.5	885	705	3,280	0.955	18.0
Twice-run oil				0.897	32.7

(*c*) Products of Distillations in Percentage by Weight:

	Crude Oil	Once-Run Oil
Water	0.3	0.0
Oil	89.5	97.73
Coke	8.4	1.55
Gas (by difference)	1.8	0.72

* The gasoline to 410 deg. F. was excluded.

cent for the paraffine-base oil, and 73.6 for the mixed-base oil. (Additional values for this increase may be found in Table III.)

(5) The second and third distillations have little effect on the percentage of saturates and unsaturates, but they show clearly the distribution of these constituents. The lighter fractions have the highest saturation (50 to 60 per cent) and the saturates decrease with the increase in gravity and boiling point and reach a minimum (18 to 40 per cent) in the heaviest fraction.

(6) The decomposition is apparently one of heavy unsaturated compounds which are unstable at the still temperatures necessary for distillation at atmospheric pressure without the introduction of steam or other gases, and is accompanied by the formation of permanent gas, coke and lighter oils containing a high percentage of saturates.

While it is quite obvious that the compounds undergoing decomposition are heavy and unstable, more experimental evidence is desirable in support of the statement that the substances decomposing are unsaturates. A subsequent paper will present the results of study along this line, the determination of some of the properties of the heavy constituents of shale oils, and a discussion of the results obtained in the different portions of the investigation.

Colorado School of Mines,
Golden, Col.

Section of Sugar Chemistry and Technology, A.C.S.

AT THE Rochester meeting of the American Chemical Society, thirty-three papers were presented before the Section of Sugar Chemistry and Technology, as compared with the very few read at the St. Louis meeting and seventeen at the Chicago meeting last September. Approximately 150 enrolled as members of the section. The members voted to request that the section be made a division; that present officers be re-elected until the creation of the division; that the executive committee be authorized to pass judgment on all papers for the next meeting, assigning a time limit for reading and accepting or refusing papers, as seems best.

In addition to a number of papers presented which described improved methods of analysis and laboratory equipment designed to make possible more accurate factory control work, the following papers were concerned more especially with the technology of cane and beet sugar manufacture.

A Comparison of the Results in the Process of Desugarization With the Steffen Lime-Process, the Barium Process and the Strontium Process, by M. Potvliet. Experimental work indicated by the title was described. Processes were compared on the basis of purity of resulting liquors 81.4 per cent for the lime, 93.79 per cent for the barium and 90.90 per cent for the strontium process. Fewer operations were said to be necessary to extract the sucrose from molasses by the barium and strontium processes. Of the sugar originally present in the molasses there was obtained as granulated sugar by the lime process 35.45 per cent, by the barium process 43.94 per cent and by the strontium process 43.18 per cent. It was claimed that not the slightest trace of barium is present in the final sugar and that more raffinose is found to be eliminated by the barium process. In the discussion which followed the presentation of this paper, the statement regarding the entire absence of barium was questioned.

The Effect of Varying Hydrogen Ion Concentration Upon the Decolorization of Cane Juice With Carbon, by J. F. Brewster and W. G. Raines. *The Effect of Some Decolorizing Carbons on the Color and Colloids of Cane Juice*, by J. F. Brewster and W. G. Raines. These two papers reported the results of experimental work with four different carbons. Emphasis was laid on the fact that decolorization depends greatly on the hydrogen ion concentration, but that it is not best to use too high hydrogen ion concentration on account of inversion. It was found that simply acidifying also produced decolorization; this point was considered in the conclusions. It was found also that by adding the carbon, heating, and acidifying with H_3PO_4 to the desired hydrogen ion concentration, and also adding enough lime before filtration sufficiently to reduce acidity, equally good decolorization was obtained and the $Ca_3(PO_4)_2$ was removed at the same time. Inversion was tested by boiling the juice at various hydrogen ion concentrations. Both color and colloids removed were determined after the use of different carbons, and these results were compared with color and colloids removed by the sulphur-lime process. Regulation of the hydrogen ion concentration is a much better method for controlling acidity than the usual method of titration.

A Study of Beet Gum—I. Separation From Final Molasses, by H. S. Paine and C. F. Walton, Jr. A considerable amount of gum was prepared from final molasses by dialysis, and various preliminary tests made of its composition and properties. A minimum specific rotation of about — 29 deg., changing after hydrolysis to about + 58 deg., was indicated. The gum was precipitated by an alcohol-acid mixture. The material yielded 32 per cent furfural phloroglucide. A positive test for galactan by the mucic acid method was not obtained. The gum increased the viscosity of sugar solutions and incidentally color, to a much greater extent than would be expected from its actual weight. Crystallization experiments indicated that the gum exerts a marked effect in diminishing the rate of crystallization of sucrose.

Colloids in Beet Sugar House Liquors and Products, by H. S. Paine, C. G. Church and F. W. Reynolds. The primary object was to determine the amount and character of the colloidal material present at successive stages in the factory, to ascertain the importance of the rôle played by colloids in sugar-house difficulties, and to attempt the solution of such difficulties. Colloids were determined by dialysis. Organic rather than inorganic colloids apparently play the predominant part in factory troubles of colloidal character; the organic colloidal material not eliminated by clarification consists to a considerable extent of one or more gums. Gum was found in relatively considerable amount in washed cold saccharate cake. A substance resembling pectin in its reactions was found in diffusion juice, but not in the subsequent products. Under usual factory conditions the amount of colloids present is apparently primarily dependent upon the character of the beets worked.

Sugar Filtration in Factories and Refineries, by H. J. Runyon, Jr. This was a very interesting paper from the engineering point of view both to sugar-houses and refineries but applies principally to refining practices. The author stated that lime and phosphoric acid defecation has become unsatisfactory in refineries with the advent of pressure filtration, because the precipitate is too gelatinous; it has been largely displaced by kieselguhr and the use of filters of the Sweetland type.

Breadth and Scope of Chemical Patent Claims*

Review of Decisions Holding Patent Claims Void for Undue Breadth and of Others Holding Them Valid for Merited Scope—Citations From Cases Bearing on Chemical Equivalents and Essential Differences

By C. H. BIESTERFELD

INVENTORS working along chemical lines are frequently confronted with the question of properly drafting comprehensive claims to cover a number of substances which they have successfully employed in new processes or compositions. In many cases such substances belong to the same chemical family and in some cases they do not. In some cases they constitute distinct species and in some cases only equivalents. The courts have clearly decided questions relating to the scope and construction of chemical claims which cover a group of substances, and the following is a digest of most of the cases.

Cases Holding Claims Void for Undue Breadth

Incandescent lamp patent, 73 O. G., 1,289. The claims covered "carbonized fibrous or textile material," although the patentee had made filaments out of carbonized paper only, and had not discovered any other species of carbonized fibrous or textile material. It was proved that bamboo was particularly valuable as a filament and the court held that the claims were void for undue breadth, saying that there was no generic quality in all such materials which adapted them to the purpose.

Matheson vs. Campbell, 78 Fed., 910. The patentee tried to cover "any sulpho acids of any radical," which included 100 or more substances, and he described only a few. The evidence showed that most of the group of 100 were inoperative. Held that he could not speculate on the equivalents of his invention and he was not entitled to a monopoly of all substances which might be found by future experiments to be equivalents of his three or four disclosed substances.

Rickard vs. DuBon, 97 Fed., 96. The claim recited "applying an alkali to the leaves," but the specification named only KOH and the evidence in the trial showed that NaOH was inoperative when applied to leaves. The court held the claim void as being too broad.

Bracewell vs. Passaic Print Works, 107 Fed., 467. The claim covered all zinc compounds, although the specification described only zinc oxide, hydrate and carbonate. The evidence showed that zinc sulphide and chloride would fail and that the chemists were agreed that untried zinc compounds could not be used with certainty. Patentee tried to have the specification read into the claim, but the court refused, since his specification said "any zinc compound may be employed." The court held the claim void, saying: "He stretched his net to catch as infringers all users of zinc compounds, and if he has stretched it to the breaking point, he has only himself to blame. The courts should be liberal in construing patents, but they cannot rewrite the description and claims; they cannot construct an entirely new patent even to save a meritorious invention. If the complainant's contention be correct, a patentee can claim blindly an entire group of compounds, relying on the court after subsequent investigation and experiment to limit the claim to the one which gives the best results. This will not do."

Lumber Anti-Stain vs. Nester, 178 Fed., 927. Claim 1 recited "applying to wood a weak alkaline solution," and the specification described $NaHCO_3$. Claim 1 was met in terms by lime water applied to wood, and the court refused to limit the claim to $NaHCO_3$ because the patentee had nowhere shown any intention to so limit it. Claim 1 was held void. Claim 2 covering only $NaHCO_3$ was also held void because the patentee had regarded lime water and $NaHCO_3$ as equivalents.

Empire Circuit Co. vs. Channon, 168 Fed., 705. The claim said "non-combustible and non-conducting material," the specification describing a fire curtain made of asbestos or the like on one side, and metal on the other. The prior art showed a curtain of firebrick on one side and the court held the claim anticipated, refusing to narrow it because the patentee had nowhere indicated his intention to place a limited meaning upon the broad terms used.

Dosselman vs. Neymann, 167 O. G., 983. Patent Office decision. The claims recited "ketonic finish softening material," but only acetone was described in the specification and it did not appear that all ketones would operate for the purpose described. The claim was rejected.

Ex parte Steinmetz, 224 O. G., 363. The claim recited "titanium compounds," but the specification described only TiC and TiO_2 as being fit for electrodes. Commissioner Ewing held the claims too broad.

Excelsior Drum vs. Scheip & Vandergrift, 173 Fed., 312. The claim recited "a reinforcing band," but the specification described only a spirally wound band surrounding a horn between its ends. The claim was held void as being too broad on the ground that a broad claim cannot be based on a description that is limited to a single device and does not present it as an example of a preferred structure. This case shows that the doctrine has been applied to mechanical cases also.

Cases Holding Such Broad Claims Valid

American Sulphite vs. Howland Falls, 60 Fed., 395. The claim recited "a continuous lining of cement," and the specification stated that the lining might be of any material which is acid resisting and capable of being made plastic and adhesive. . . . A convenient material is portland cement . . . cement mixtures, sand and portland cement, sand and tar, etc." Held that the claim covered all cements having the properties set forth and that equivalents must be such as skilled chem-

*Journal of the Patent Office Society, vol. 2, No. 12, pp. 598-608, August, 1920.

ists might be expected to find as answering the requirements of the described conditions.

Fullerton vs. Anderson, 166 Fed., 443. The claim called for bleaching nuts by a "weak acid," while the specification stated that acetic acid, among other acids, was suitable for liberating chlorine for bleaching. Sulphuric acid was not described, but the court held that it came within the term "weak acid" and that the patentee was not obliged to experiment with all weak acids and that any acid which would liberate chlorine would be covered. The court intimated that some weak acids might be inoperative but that the commoner ones would be operative, and therefore the broad claim was valid. In this case any chemist could readily mention the weak acids which would liberate chlorine for bleaching purposes.

Welsbach vs. Sunlight, 87 Fed., 221. The claims covered "paraffine or other suitable material," and the specification said that any substance setting hard at ordinary temperatures and burning without mechanical destruction of the mantle would suffice. It was proved that collodion was known to have these properties at the date of the patent and it was therefore held an equivalent. The claims covered, under the construction given them by the court, all substances which were known by chemists to answer the requirements of the specifications.

Malignani vs. Hill-Wright Electric Co., 177 Fed., 430. The claims covered all substances which would "gasify by heat and combine with gases generated by the filament," while the specification mentioned arsenic, sulphur and iodine for the purpose of removing the oxygen. This claim was held valid, the court saying that the patentee was not required to specify all known substances which might be used and that the claim covered all such known substances, including phosphorus. This case held as valid a comprehensive claim which was functionally stated.

There is a unanimity of opinion in all these cases. They hold that in order to sustain a broad claim covering a whole class or group of substances, it must appear either (1) that the inventor has shown with reasonable certainty in the specification that all the members of the group claimed are operative, or (2) that it would be obvious to the average chemist that all the members of the group are operative. If upon trial the evidence shows some members to be anticipated or inoperative, the claim is held void unless the patentee in his specification indicated that he confined himself to his described substances and their equivalents.

How Can Inventor Claim Protection?

The question arises, How may the inventor obtain protection for those members of the class which his specification enumerates? Is it necessary for him to try them all out before filing a broad claim? Will it suffice for him to claim only one preferred substance and state in the specification that the others are equivalents, thereby hoping to gain the protection of the doctrine of equivalents? In re Ellis, 167 O. G., 981, is apparently the only decision which attempts to solve this difficulty. Ellis had claimed all "cyclic CH_2 hydrocarbons" as ingredients of finish solvents, and his specification had named about twenty such hydrocarbons. The term "cyclic CH_2 hydrocarbons" was apparently the only generic expression which could include the substances named. The Court of Appeals held the claim valid in a well-considered decision in which the following points were brought out:

(1) It is unnecessary to investigate experimentally all members of the class, but only necessary to enumerate a fairly representative number to make it appear that the whole class is operative.

(2) There must be a claim in the case sufficiently broad to cover the whole class and such claim must define the essential quality of the class which renders it operative for the purpose described.

(3) Should any members of the class be found later to be inoperative, the court will restrict the claim to cover only the members described and their equivalents.

In regard to the first point, all that is necessary is to describe a fairly representative number, say from ten to twenty of the members of the class, to establish a prima facie case of operativeness for the whole class.

Claim Must Be Comprehensive

In regard to the second point, there must be a comprehensive claim, and it will not suffice to claim only one member. The only authority cited by the Court of Appeals is Read Holliday vs. Shulze-Berge, 78 Fed., 493, but this case was only dictum and it confused the distinction between species and equivalents. An equivalent is a thing which performs the same function, and performs that function in substantially the same manner as a thing of which it is alleged to be an equivalent. (Walker, par. 354.) An equivalent for one ingredient of a patented composition of matter is anything which in that composition performs the same function as that ingredient. (Walker, par. 370.) A patentee is always entitled to equivalents regardless of whether or not he has broad claims to cover them. One of the very few chemical cases clearly illustrating this doctrine is Treibacher vs. Roessler & Hasslacher, 219 Fed., 210. Here the claim covered a "pyrophoric alloy containing cerium alloyed with iron, substantially as and for the purposes described," while the specification stated that nickel or cobalt and their equivalents might be used in place of iron, there being, however, no broad claim to cover such equivalents. The court held that Mg was an equivalent of iron and accordingly a cerium: magnesium alloy infringed the claim. This same doctrine is supported in the mechanical cases, such as Weinans vs. Denmeed, 15 Howard, 341; Bundy vs. Detroit, 94 Fed., 524-538; Metallic Co. vs. Brown, 104 Fed., 345; Soehner vs. Stove Co., 84 Fed., 185; Vrooman vs. Penhollow, 179 Fed., 296; Whitin Machine Works vs. Houghton, 178 Fed., 444.

Species on the other hand are not equivalents, and therefore comprehensive claims are needed to cover them. (Monroe vs. McGreer, 81 Fed., 954.) Species are distinct inventions and involve patentable differences. "No range of equivalents can overcome a patentable difference." (Cheatham Electric vs. B.R.T., 238 Fed., 172.) In in re Ellis the various cyclic CH_2 hydrocarbons constituted distinct species and therefore a broad claim was needed in order to cover them.

With regard to the third point of in re Ellis, the question arises as to how far the court will go in reading the specification into the claim, in case the claim is met by the prior art or is too broad in view of the fact that some of the members of the broad class have been shown to be inoperative. The answer is that if the patentee in his specification indicated that he intended to claim broadly the court will hold

him to it and the claim will be void absolutely. In Cambria Iron Co. vs. Carnegie Steel Co., 96 Fed., 850, the patentee claimed a process of mixing molten metal and indicated that he intended to claim broadly, and the court so considered it. In this connection it may be stated that the courts will read the specification into a claim where a non-patentable function has been claimed and the specification describes as essential the element which was functionally claimed (Westinghouse vs. Boyden, 170 U. S., 537); or where an essential subordinate feature was omitted in the claim (Lamb Knit Goods vs. Lamb Glove Co., 120 Fed., 267); or where a subordinate essential element was omitted in the claim (Walker, par. 182; Wellman vs. Midland Steel Co., 106 Fed., 221), but where the specification shows that the patentee deliberately intended to claim broadly the claim will be construed broadly and will not be restricted for the purpose of escaping anticipation or invalidity (Empire Circuit Co. vs. Channon, *supra*, and other cases cited in the beginning of this article; General Sub Construction Co. vs. Netcher, 167 Fed., 549). The court indicated in in re Ellis that in the event of finding any of the members of the class of cyclic CH_2 hydrocarbons inoperative, the claims would be restricted to the substances named in the specification and their equivalents. This was because Ellis intended to cover in his claims only his described substances and their equivalents.

The question arises, What would Ellis be entitled to in the way of equivalents? Would he be entitled to every cyclic CH_2 hydrocarbon not mentioned by him which was found operative? The answer seems to be that where experimentation is necessary to determine which members are operative and which members are not, the patentee cannot cover such members in his claims unless he has mentioned them in his specification. (Matheson vs. Campbell; Rickard vs. DuBon; Bracewell vs. Passaic Print Works.)

Patentee Should Have Benefit of His Research

These decisions are not quite conclusive, however, for in each of these cases only a few members of a large class were described in the specification. It is believed that where a patentee describes a large number of members of a class, such as in in re Ellis, he should be entitled to every operative member of that class, even though some members are later found to be inoperative. The reason for this will be clear when we consider that it very often requires considerable original research and thought to conceive and work out a broad class for a particular process or composition, whereas the inventive skill necessary to experiment with various members of the class when once an earlier inventor has already broken the ice and opened up the class will be much inferior to the inventive act of the inventor of the class. In fact it hardly appears to amount to invention at all to determine experimentally what members of a class once discovered are operative or inoperative, for the average skilled chemist could readily perform the task. Where no invention is required to discover a new member of a known and patented class, it is to be considered an equivalent of the members described by the patentee. (Read Holliday vs. Shulze-Berge; American Sulphite vs. Howland Falls, *supra.*) Such equivalents discovered subsequent to the date of a patent would be covered even by its specific claims and therefore the patentee should have the right to draw claims to cover broadly any subsequently discovered equivalents. There is no decision, however, clearly giving him this right. The nearest case is Minerals Separation Co. vs. Hyde, 242 U. S., 261, where different ores were treated and different preliminary tests were necessary to determine the amount of oil needed and the extent of agitation. The court said: "The process is one for dealing with a large class of substances and the range of treatment within the terms of the claims, while leaving something to the skill of persons applying the invention, is clearly sufficiently definite to guide those skilled in the art to its successful application."

Cases on Chemical Equivalents

It will therefore be apparent that the claims of a patent, however broad, cover only the substances described in the specification and their equivalents. (Hall Borchert vs. Ellenam, 213 Fed., 341.) The patent covers only such substances not described therein which the average skilled chemist at the date of the patent knew to be equivalents of the substances described (Heath vs. Unwin, 2 Web., 236), and such equivalents as might be discovered later without the exercise of invention. (Read Holliday vs. Shulze-Berge; American Sulphite vs. Howland Falls, *supra.*) It is not sufficient to show that a substance unknown at the date of the patent proves by tests to be an equivalent, if invention was exercised. (Paint Co. vs. Bird, 175 Fed., 346.) Generally the issuance of a patent negatives the fact of equivalency where it is contended that the substance claimed in the patent is an equivalent of previously patented substances. (American Sulphite Pulp vs. Hinckley Co., 217 Fed., 57, where a claim for an acid-resisting lining of cement was held not infringed by a new composition claimed in a subsequent patent, the new composition being unknown at the date of the first patent.) Where an ingredient substituted for a substance mentioned in the patent performs the required function better than the patent ingredient and in a different manner it may still be an equivalent. Thus, a claim covering dynamite made from infusorial earth and nitroglycerine was infringed by an equivalent explosive made from mica and nitroglycerine, although mica did not absorb the nitroglycerine like the infusorial earth and as a result produced a more powerful explosive. (Atlantic Giant Powder Co. vs. Mowbray, 2 Bann. & Ard., 447.) Where a patentee fails to obtain results with a certain substance he cannot claim it as an equivalent; thus where an inventor was unsuccessful with mica he could not cover it as an equivalent of the glass which he described and claimed broadly as "non-porous vitreous material." (Folger vs. Dow Electric Co., 133 Fed., 295.) Where a patentee intentionally avoids a certain substance, the composition which includes it is not an equivalent and does not infringe. Thus where a patentee claims a disinfectant consisting of camphor oil containing HCHO and states that no water should be present, it is not infringed by a disinfectant containing aqueous formalin and eucalyptus oil. (Orr vs. Aschenbach, 225 Fed., 71.)

In Tilghman vs. Proctor, 102 U. S., 730, saponification by lime water at a low temperature and pressure was held equivalent to saponification by water at a high temperature and pressure.

In Miami Copper Co. vs. Minerals Separation Co., 244 Fed., 752, the patentee formed a froth by mechanically beating air into mineral pulp containing under

1 per cent oil by means of a mechanical beater and he referred to this process in his claim by the broad term "agitating." The alleged infringer formed a froth by bubbling air through a column of pulp, the resulting agitation being mild and not mechanical. The two processes were held equivalent to each other.

In Hoskins Manufacturing vs. General Electric, 212 Fed., 422, an alloy of nickel 65 per cent, chromium 12 per cent, iron 15 per cent and manganese 8 per cent was held to infringe a resistance element composed of a nickel: chromium alloy upon the theory that the addition of the iron and manganese did not materially change the alloy as a resistance element.

In Gordon vs. Turco-Halvah Co., 233 Fed., 430, the claim specified peanut butter, but the specification stated that oily matter generally might be used, and the court held that maize oil was an equivalent. In a second patent in this suit the claim specified cottonseed oil and the specification described no equivalents nor said anything about them, and the court limited the claim to cottonseed oil. The restriction of the claim in the second patent seems to have been rather severe.

If a patentee in his effort to avoid claiming too broadly should unnecessarily restrict his claims, the court will construe them disregarding the limitation, provided the specification shows that the limitation pertains to the operative environment rather than to the inventive step and the limitation does not import a function which the patentee considered important or essential. (D'Arcy Spring Co. vs. Marshall Mattress Co., 270 O. G., 347; Arnold Creager vs. Barkwill, 246 Fed., 441; Loraine vs. General Electric, 198 Fed., 100.) Where the Patent Office rejects a claim and the applicant accepts a more restricted claim, he is bound by it, although he may have unduly restricted. Where a claim is clear there is no room for construction and the patentee cannot be heard in court to contend for that which he unnecessarily surrendered in the Patent Office in avoiding a rejection. (United States Glass Co. vs. Atlas Glass Co., 88 Fed., 493.) In such cases he is, however, still entitled to equivalents and is not exactly pinned down to the exact language of his claims. (Consolidated Roller Mill vs. Coombs, 39 Fed., 25.) It might be mentioned in this connection that a chemical product claim is not limited to the product of the process described, even though that is the only known process. (Maurer vs. Dickenson, 113 Fed., 870.)

Electrolytic Zinc in England

Great Britain has never been self-sufficient in zinc production. For instance, in 1913 the production was 60,000 tons and the consumption 220,000 tons. During the past five years the annual production had been 50,000 tons, against a consumption of 180,000 tons. Today its zinc industry is sorely depressed and is operating at less than 20,000 tons per annum since the recent closure of all the large smelters in South Wales. Although British supplies of high-grade ores are important, they cannot be mined and distilled at present prices for spelter. In fact, Germany is the only country which can produce at a profit, solely due to the depreciated exchange. Samuel Field has recently read a paper before the Faraday Society stating that the electrolytic process can now be regarded as a commercial possibility, in view of the fact that it can handle low-grade ores and recover other metals contained as a byproduct. Power in large blocks was to be had in 1917 for 0.34d. per kw.-hr. (⅔c.) and probably would not go above that if the works were placed near the collieries. There are actually large bodies of complex zinc ores within close reach of certain Scotch collieries, making almost ideal conditions. The cost should then be, in a 10-ton plant, using three-stage purification, and labor at 10s. per 8-hr. shift (30c. per hr.):

	£	s.		£	s.
Calcination	2	00	Supplies	1	00
Power	5	11	Salaries and wages	4	10
Reagents	3	00	Interest and depreciation	3	00
Melting cathodes	1	10			
			Total	20	11

Or $100 per long ton.

With a concentrate of 40 per cent Zn, 10 per cent Pb and 5 oz. silver, delivered at £5 per ton, and crediting byproducts recovered, the total cost of zinc should not be more than £24 per long ton (5.2c. per lb.).

While no plans for large-scale production are under development, the British Metals Extraction Co., Ltd., has a small plant in operation near Swansea, South Wales. It is on somewhat more than a laboratory scale, having made about 100 tons zinc, and accumulated valuable information necessary for tonnage production.

Graphite Industry in 1920

The quantity of domestic flake and amorphous graphite sold by producers in the United States in 1920 amounted to 9,510 short tons, an increase of 28 per cent over the quantity sold in 1919.

The value of the graphite sold in 1920 was about $626,201, as compared with $778,857 in 1919. These figures are based on reports made by producers to the U. S. Geological Survey.

Operators in Colorado, Nevada and Rhode Island reported sales of 4,694 short tons of amorphous graphite in 1920 at an average price of $10.60 a ton. This was $3.52 per ton less than the average price in 1919.

The sales of crystalline graphite in 1920 amounted to 9,632,360 lb., valued at $576,443, as compared with 8,086,191 lb., valued at $731,141, in 1919. The average price per pound in 1920 was 5.9c.; in 1919 it was 9c. Alabama led in the production of crystalline graphite, the sales in 1920 amounting to 4,894,648 lb., or 51 per cent of the total quantity sold.

The sales reported from New York and Pennsylvania amounted to 3,552,687 lb., or 37 per cent of the total in the United States, and the remaining 13 per cent was reported from California, Montana and Texas.

The Acheson Co. reported the sale of 7,399,749 lb. of artificial graphite made at Niagara Falls.

DOMESTIC GRAPHITE SOLD IN 1915-1920
(Short tons)

	Amorphous		Crystalline		Total	
Year	Quantity	Value	Quantity	Value	Quantity	Value
1915	1,181	$12,358	3,537	$417,273	4,718	$429,639
1916	2,622	20,723	5,466	914,748	8,088	935,471
1917	8,301	73,481	5,292	1,094,398	13,593	1,167,879
1918	6,560	69,455	6,431	1,454,799	12,991	1,524,254
1919	3,379	47,716	4,043	7,731,141	7,422	778,857
1920	4,694	49,758	4,816	576,443	9,510	626,201

GRAPHITE MANUFACTURED BY THE ACHESON GRAPHITE CO. 1915-1920

	Pounds		Pounds
1915	5,084,000	1918	9,182,272
1916	8,397,281	1919	8,163,177
1917	10,474,649	1920	7,397,749

GRAPHITE IMPORTED INTO THE UNITED STATES IN 1920*

	Quantity			Quantity	
Country of Origin	(Short tons)	Value	Country of Origin	(Short tons)	Value
Ceylon	9,204	$1,077,290	Italy	137	5,072
Madagascar	4,710	286,383	Austria	58	1,195
Canada	2,170	157,015	Germany	30	2,502
Brazil	.....	.....	Other countries	317	20,087
Mexico	3,659	131,832			
Chosen (Korea)	810	29,936		21,095	1,711,312

* These figures are preliminary and subject to revision.

Condensation of Zinc Vapor*

A Zinc Retort and Separate Condenser Were Maintained Under Close Temperature Control, and the Amount of Zinc Dust Determined When Condensing It From a Stream of Carbon Monoxide, Water Vapor or Nitrogen

BY OYSTEIN RAVNER

AS IS well known, zinc is generally produced by heating and reducing zinc oxide by means of carbon. At the high temperature employed the metal is distilled and the vapors condensed. However, the vapor is not completely liquefied, but part of it is deposited as a finely divided powder (zinc dust), which entirely lacks the properties of metallic zinc.

Lately, electric power has been avantageously used for producing zinc. In this case also the oxide is reduced by means of carbon, but the heat is supplied by an electric current. This process has many advantages, but the formation of a considerably greater amount of dust apparently cannot be avoided. Thus a roasted ore with 20 per cent Zn will give almost exclusively dust, ore with 40 to 50 per cent Zn will give equal amounts of zinc and dust, and ore with 60 to 70 per cent Zn will give two parts zinc to one part dust.

As zinc dust has not even approximately the same value as metallic zinc, it is generally returned to the furnace, charged together with the ore and the process repeated. The spelter thus obtained is sometimes distilled again in order to obtain pure zinc. We have therefore two distillations, and consequently the formation of dust twice during the complete process.

Very few systematic investigations have been made to determine the cause of the formation of zinc dust. Early investigators have noted (for instance, at the Belgian smelters, where closed retorts are used) that the formation of dust is more conspicuous at the beginning of distillation. At that time gases are evolved from the charge, and the zinc vapors therefore become more diluted. It has also been shown that the temperature of the condenser influences the formation of dust.

EXPERIMENTAL PROCEDURE

It was the purpose of the following tests to show as far as possible what results might be expected when distilling zinc under various technically possible conditions. Tests were therefore made to distill zinc in various gases and with various condensing temperatures. Many tests have been made particularly with carbon monoxide, as this gas is always present in great quantities, according to the reaction

$$ZnO + C = Zn + CO$$

Zinc from an electric furnace was used, guaranteed to contain 99.9 per cent Zn. The following impurities were found: Pb 0.073 per cent, Cd 0.018 per cent, Fe 0.005 per cent, As 0.003 per cent; total 0.099 per cent.

The tests were made in such a way that a definite, weighed amount of zinc was introduced in a porcelain boat into an electric tube furnace, heated to 915 deg. C. The furnace (Fig. 1) was provided with entrance and exit tubes for the gas, a Le Chatelier pyrometer (T), and was connected with a receiver for condensation of the zinc vapors.

The furnace consisted of a steel pipe, wound with resistance wire and covered with insulating material. The pipe was tightly closed at one end; the other end was provided with a flange. As will be seen from Figs. 1 and 2, the furnace was closed with a steel plate provided with an asbestos plug of such a length that the temperature of the muffle was kept constant at 915 deg. C.

The condensing receiver was arranged so that the vapors entered a glazed clay cylinder, at the bottom of which the liquid zinc was collected in a porcelain crucible. The dust was deposited in the chamber around the crucible, and such of it as escaped from the cylinder was collected in a bottle with glass wool, and in a U-tube containing a little glycerine to keep the air out. The clay cylinder was closed at the top

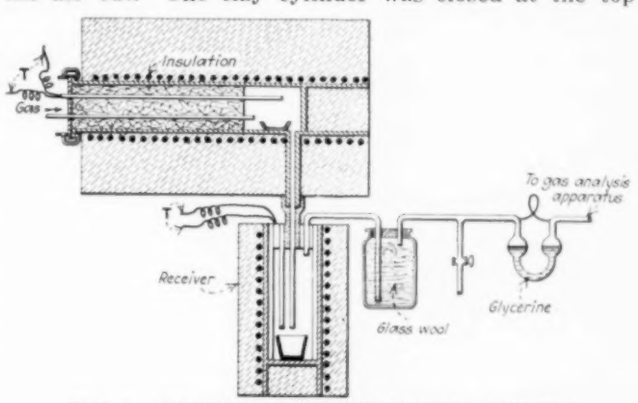


FIG. 1. SKETCH OF EXPERIMENTAL RETORT AND CONDENSER

with a tight-fitting asbestos plug. It was also provided with a Le Chatelier pyrometer (T) and was heated in an electric crucible furnace.

The results from the tests may suitably be arranged in the following groups:

Group 1 comprises:

1. The influence of the dilution of the zinc vapors on the amount of dust.

2. The influence of the carbon monoxide on the formation of dust at various velocities of the gas and temperatures of the condenser.

Group 2 comprises the influence of moisture (steam) on condensation.

Group 3 comprises the influence of nitrogen on condensation of zinc.

DILUTION OF ZINC VAPOR

Thirty liters of carbon monoxide was used for each test. It was made from potassium ferrocyanide and

*Translated from *Tidsskrift for Bergvaesen*, 1919, No. 10, p. 121. Portions of a dissertation prepared at the Institute of Inorganic and Physical Chemistry, Dr. P. Farup, director, Technical High School of Norway.

TABLE I.

Test	Velocity of of the CO Stream, c.c. per Min.	Amount of Zinc in the Receiver, g.	Amount of Dust, g.	Dust, per Cent
1	0	16.75	0.18	1.07
2	5	17.42	0.34	1.95
3	10	28.48	0.56	1.97
4	20	25.52	1.42	5.56
5	30	26.60	2.05	7.71

concentrated sulphuric acid, metered and passed through potassium hydroxide, calcium chloride and concentrated sulphuric acid. The amount of zinc used was 30 g.

Table I shows the results from the first series of tests with the condenser at a constant temperature of 470 deg. C. In the first test the furnace temperature was 940 deg. C. (20 deg. above the boiling point of zinc); in the others, 915 deg. C. That is to say, the first experiment represents distillation of zinc under atmospheric pressure of its own vapor. It is evident from the test that the more dust that is obtained the more diluted the zinc vapors are.

Now the laws in regard to the condensation of zinc vapor are the same as the laws for condensation of gases in general. If a given amount of saturated zinc vapor is contained in a chamber, the walls of which have a lower temperature than the vapor, metallic zinc will precipitate along these walls. If the walls have a temperature below the melting point of zinc (418.2 deg. C.) the metal will be deposited as a finely divided solid. If, on the contrary, the temperature of the walls is above the melting point of the metal, liquid zinc will be obtained, and the condensation will continue until the pressure of the zinc vapor has dropped to that value correct for the prevailing temperature. When this condition has been reached, the condensation will end, in case the chamber is not cooled further and no more vapor is introduced. Therefore, from a theoretical point of view at every predetermined temperature a certain amount of zinc vapor will remain uncondensed. The possible presence of inactive gases causes the pressure of the zinc vapor to be only a fraction of the total pressure of the atmosphere or the gas mixture. Condensation will then take place at a lower temperature — i.e., when the maximum vapor pressure of the zinc equals the partial pressure of zinc in the gas mixture. Condensation will continue with further cooling, the gas mixture, however, always being saturated with zinc vapor. In other words, saturated vapor is simply a gaseous substance in equilibrium with its liquid or solid phase.

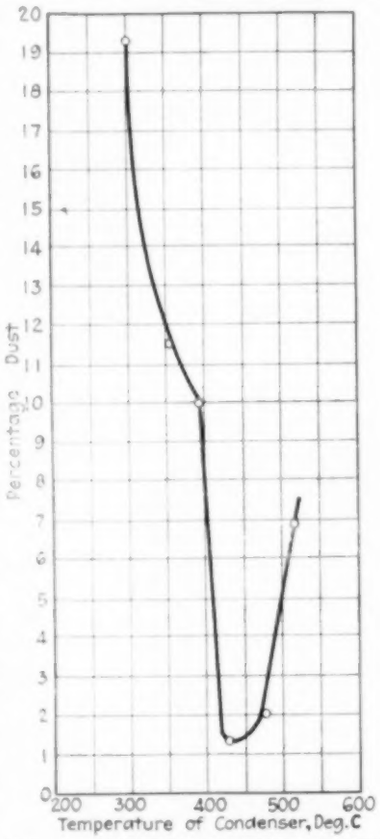


FIG. 2. AMOUNT OF DUST MADE WHEN CONDENSING ZINC FROM A STREAM OF 10 C.C. CO PER MINUTE

Therefore, as a given quantity (30 g.) of zinc vapor is condensed, liquid zinc is formed, the amount of which for a certain temperature of the condensing receiver is greater the less diluted the vapor.

High Condenser Temperatures

Table II and the curve Fig. 2 show the results from the second series of tests with increasing temperatures in the condenser, but with a constant velocity of carbon monoxide of 10 c.c. per minute. For each test, 30 liters carbon monoxide and 30 g. zinc were used, and the furnace temperature was 915 deg. C.

TABLE II. VARIATION IN DUST PRODUCTION AS CONDENSER TEMPERATURE CHANGES

10 c.c. CO per min.

Test	1	2	3	4	5	6	7
Temperature in the condenser, deg. C	300	360	400	430	470	520	600
Amount of zinc in the condenser, grams	23.10	24.86	25.11	24.67	28.48	26.52	23.80
Amount of dust, grams	4.44	2.86	2.52	0.30	0.56	1.82	1.84
Dust, per cent	19.22	11.52	10.04	1.22	1.97	6.86	7.73
Average analyses of gases coming from the condenser:							
CO_2, per cent	2.6	3.2	3.5	4.9	8.4	8.8	10.3
CO, per cent	96.4	96.0	95.3	94.3	90.9	90.6	89.0
Remainder, per cent	1.0	0.8	1.2	0.8	0.7	0.6	0.7
ZnO in dust, per cent	3.91	4.05	3.98	4.28	4.41	5.21	12.62

The curve in Fig. 2 shows a decided minimum in the amount of dust produced when the condenser is held at the melting point of the metal, 418.2 deg. C.

Table III, with the curve in Fig. 3, shows the results from a third series of experiments with increasing temperatures in the receiver, but with a constant velocity of carbon monoxide of 20 c.c. per min. The only difference from the preceding series of tests is the fact that the velocity of the carbon monoxide is twice as great; 30 liters of carbon monoxide and 30 g. of zinc were used for each test. The furnace temperature was 915 deg. C.

TABLE III. VARIATION IN DUST PRODUCTON AS CONDENSER TEMPERATURE CHANGES

20 c.c. CO per min.

Test	1	2	3	4	5
Temperature in the condenser, deg. C	380	400	430	470	520
Amount of zinc in the condenser, grams	25.68	23.84	24.21	25.52	26.23
Amount of dust, grams	2.65	1.79	0.36	1.42	2.83
Dust, per cent	10.32	7.51	1.49	5.56	10.79
Average analyses of gases coming from the condenser:					
CO_2, per cent	3.6	3.9	5.2	7.1	8.2
CO, per cent	95.2	95.4	94.5	94.4	91.2
Remainder, per cent	1.2	0.7	0.3	0.5	0.6
ZnO in dust, per cent	3.82	3.79	4.21	4.54	5.60

As shown graphically in Fig. 3, the amount of dust increases with the temperature of the condenser, when this is above the melting point of zinc. Curve 3 also shows in comparison with Fig. 2, as the first series of tests did, that the amount of dust increases with the dilution.

Minimum Dust Formation

Both the curves (Figs. 2 and 3) show clearly that the minimum amount of dust is obtained when the temperature of the condenser is the same as the melting point of the metal. This fact may be explained as follows:

When the temperature of the condenser is below the melting point of the metal, the zinc will be condensed in a finely divided, solid state (dust), and the amount of this dust will increase with decreasing temperature. That the amount of dust increases with increasing

temperature in the condenser above the melting point of the metal may be due to the fact that zinc acquires a perceptible vapor pressure as soon as the melting point has been passed.

According to Clausius, the vapor pressure of the zinc

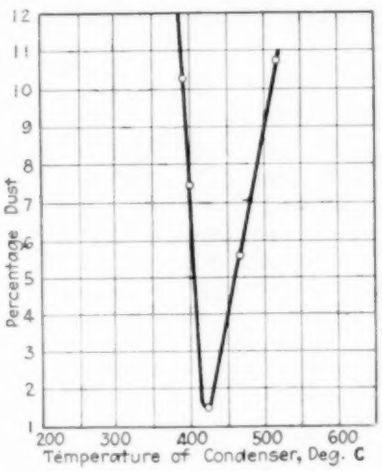


FIG. 3. AMOUNT OF DUST MADE WHEN CONDENSING ZINC FROM A STREAM OF 20 C.C. CO PER MINUTE

may be determined for any temperature, as soon as it is known for one certain temperature. We have:

$$\frac{d \ln p_1}{dT} = \frac{L}{RT_1^2} \qquad (1)$$

Here p denotes the vapor pressure, and L the molecular latent heat of vaporization at absolute temperature T_1. R is the calorimetric gas constant = 1.985.

By integrating equation (1) we obtain:

$$\ln p_1 = -\frac{L}{RT_1} + C \qquad (2)$$

If we now know the pressure of the zinc p_2 at a corresponding temperature T_2, the constant C may be determined.

$$\ln p_2 = -\frac{L}{RT_2} + C$$

By inserting this value for C in equation (2) we obtain, when we assume L to be constant between the temperatures T_1 and T_2:

$$\ln p_1 = \ln p_2 - \frac{L(T_2 - T_1)}{RT_1T_2}$$

or

$$\log p_1 = \log p_2 - \frac{L(T_2 - T_1)}{2.3RT_1T_2}$$

Schenck[1] finds p_2 to be 10 mm. at 582 deg. and L = 27,670 cal. From these data and the preceding

TABLE IV. FOUND AND CALCULATED VALUES OF AMOUNT OF ZINC DUST

Test (Table II)	Temp. of Receiver	Amount of Dust Found, g.	Calculated: Amount Uncondensed Zinc, g.	Calculated: The Zinc Pressure, m.m.
4	430	0.30	0.031	0.29
5	470	0.56	0.096	0.89
6	520	1.82	0.297	2.79
7	600	1.84	1.539	14.00

equations the pressures for other temperatures may be calculated as in Table IV.

The amount of uncondensed zinc is calculated as follows.

[1] Physikalische Chemie der Metalle.

At 430 deg. the vapor pressure of zinc is 0.29 mm. and that of the carbon monoxide 760 — 0.29 = 759.71 mm. Therefore, for one volume of carbon monoxide which leaves the receiver, $\frac{0.29}{759.71}$ volumes of zinc vapor escape. Thirty liters of carbon monoxide at 20 deg. was used for the test. At 430 deg. its volume will be:

$$\frac{30(430 + 273)}{20 + 273} = 71.98 \text{ liters CO}$$

The zinc escaped is therefore:

$$\frac{0.29 \times 71.98}{759.71} = 0.0275 \text{ liter zinc vapor}$$

at 430 deg. and 760 mm. pressure.

Reduced to 0 deg. and 760 mm., it will be:

$$\frac{0.0275 \times 273}{430 + 273} = 0.0107 \text{ liter zinc vapor}$$

As zinc in the gaseous state is monatomic, 22.4 liters of zinc vapor at 0 deg. and 760 mm. corresponds to 1 gram-atom of zinc or 65.37 g.; 0.0107 liter of zinc vapor therefore corresponds to 0.031 g. zinc.

It will be seen from Table IV that the actual amounts of dust produced are greater than the calculated values of uncondensed zinc. This may be because more zinc is taken along with the gases than the amount corresponding to the vapor pressure of the metal at the temperature in question. However, to judge from the tests, the principal cause of high dust production seems to be some subsidiary chemical reactions.

The gas analyses in Tables II and III show that the percentage of carbon monoxide in the gases, as well as the amount of zinc oxide in the dust, increases with the temperature of the receiver. It may therefore be assumed that the carbon monoxide is split up according to the formula:

$$2CO = CO_2 + C \qquad (3)$$

During the condensation, small drops of zinc are formed, and if now carbon dioxide is present, according to (3), a film of zinc oxide may be formed around these, according to the formula:

$$n + CO_2 = ZnO + CO$$

This film will prevent the separate drops from running together; they follow the stream of gas, and are collected as dust.

As is evident from Tables II and III, it was not possible to obtain the total amount of zinc in the condenser. It was discovered that the greater part of this amount lacking was deposited in the pipe leading from the furnace; after every test it needed to be removed by drilling.

This mass of zinc was not distributed along the whole pipe, but had settled on only a part of it where the temperature during the test had been between approximately 800 and 700 deg. Further down, where the temperature had been lower, no zinc had been deposited. It was also seen that the mass contained not only metallic zinc but also zinc oxide and carbon. The explanation is advanced that at 700 to 800 deg. the reaction velocity of $2CO = CO_2 + C$ is particularly high, with a corresponding high production of ZnO on the condensate. Carbon and zinc oxide are therefore formed, which, together with some liquid zinc, cause the obstruction such as often occurs at electric spelter furnaces.

The gas stream is gradually cooled as it passes on, and the reaction velocity of $2CO = CO_2 + C$ decreases,

not only on account of the lower temperature, but also because a little carbon dioxide is now present.

Influence of Moisture on Condensation

These experiments, to determine the influence of moisture on condensation, were made in such a way that carbon monoxide was passed through wash bottles containing water, which at each test were kept at a definite temperature.

The percentage by volume of water vapor in the gas may be calculated as follows: When carbon monoxide is passed through water of a certain temperature and is in contact with the water a sufficient time, it will absorb a definite amount of water vapor, corresponding to the pressure of the water at the prevailing temperature. The resulting gas mixture will consist of $\frac{x}{760}$ volumes of water vapor, and $\frac{760 - x}{760}$ volumes carbon monoxide, where x signifies the pressure of the water at the temperature used.

At 2 deg. water has a vapor pressure of 5.302 mm.
At 20 deg. it has a vapor pressure of 17.391 mm.
At 45 deg. it has a vapor pressure of 71.311 mm.

Table V shows the results from these tests. The temperature of the condenser was 430 deg. C., and the velocity of the gas 20 c.c. per min. The furnace temperature was 915 deg., and the amount of zinc used was 30 g.

TABLE V. INFLUENCE OF WATER VAPOR ON CONDENSATION

Test	1	2	3
Temperature of water in the wash bottles, deg. C.	2	20	45
Per cent by volume of water in the gases entering the furnace	0.69	2.29	9.39
Amount of zinc in the condenser, grams	23.25	17.0	8.0
Dust in the condenser, grams	1.56	.....	....
Dust, per cent	6.63	.....	....
ZnO in dust, per cent	10.51	.....	....

By comparing Experiment 1 (6.63 per cent dust) with Experiment 3 in Table III (1.49 per cent dust), it will be seen that even a small amount of moisture considerably increases the formation of dust. The tests show also that the higher the content of water in the gases the less zinc will be deposited in the receiver. It will be partly oxidized before entering, and will settle as oxide along the walls, so that the furnace finally will be clogged up. In Experiments 2 and 3 the zinc in the condenser was completely covered with oxide.

When making zinc on a large scale, the charge should therefore be as free from water as possible.

Influence of Nitrogen on Condensation

Commercial nitrogen was first passed over copper, heated to a red heat, and then through concentrated sulphuric acid. The furnace temperature was as before, 915 deg., and the temperature of the condenser was 430 deg. Thirty grams of zinc and 30 liters of nitrogen were used for the test. The nitrogen was passed through the apparatus with a velocity of 10 c.c. per min. There was found in the receiver 16.20 g. zinc, very brittle and of gray color. As the distillation had taken place in an atmosphere containing nitrogen, the zinc was dissolved in 30 per cent sulphuric acid and analyzed for nitride, Zn_3N_2. The solution was boiled with potassium hydroxide in a Kjeldahl apparatus, and the ammonia formed was absorbed in N/10 sulphuric acid. For 16.20 g. zinc 2.3 c.c. N/10 sulphuric acid was used—i.e., it contained 0.16 per cent nitride.

The zinc which was drilled out from the pipe between the furnace and the receiver was found to contain 0.14 per cent nitride. A blank test was run on the potassium hydroxide, finding it nitrogen free.

Another test conducted in the same way as No. 1, but with 20 c.c. nitrogen per min., gave 23.65 g. zinc in the condenser and 1.78 g., or 7.51 per cent dust.

For 23.65 g. zinc 3.2 c.c. N/10 sulphuric acid was used—i.e., nitride = 0.31 per cent.

Zinc Nitride

As mentioned above, the zinc was brittle and of a dull gray color. This may be due to the nitride. In the periodic table of the elements, the properties of any one element are determined by the properties of the elements in the same groups and series. Zinc will be found in the same group as beryllium, magnesium and calcium and close to aluminum in the following group. All these metals react easily with nitrogen, forming nitrides. Zinc nitride is described in the literature as a gray powder which is easily decomposed by water:

$$Zn_3N_2 + 6H_2O = 3Zn(OH)_2 + 2NH_3$$

In another test, three pieces of zinc, weighing in all 30.5 g., were heated in the furnace to 640 deg. Nitrogen was passed through the furnace during the heating as well as the cooling, and it was found at the end that the zinc pieces were still in the porcelain boat and had not run together, even though zinc melts at 418.2 deg. They were, instead, covered with a gray powder, which formed a film around each one. The nitrogen had therefore attacked only the surfaces of the zinc pieces and later protected them from further action. An analysis of the fragments gave an average of 0.70 per cent nitride.

As the pieces had not run together, it is reasonable to assume that the reaction between the nitrogen and the zinc had begun below the melting point. In the Norwegian patent 23,165, "Synthetic Production of Ammonia From Its Elements," it is stated that ammonia is formed when nitrogen and hydrogen are passed over zinc at a temperature below the melting point of the metal. According to this patent, the zinc will act as a catalyst as low as 200 deg. C. To judge from the tests, it is therefore not impossible that in the above-mentioned ammonia process a nitride is first formed on the surface of the zinc and that it is this which facilitates the combination between the two elements.

One further finds in *Chemisches Centralblatt*, 1916, vol. 2, No. 2, that dry gaseous ammonia reacts with zinc dust and forms nitride. The most favorable temperature is 600 deg. C., and a product with up to 10.6 per cent nitrogen is obtained; since Zn_3N_2 corresponds to 12.5 per cent N, the end product contained 85 per cent nitride. As nitride has a high dissociation pressure at its temperature of formation and it is therefore difficult to obtain it entirely free from zinc, the substance may be assumed to be a mixture or solid solution of $Zn_3N_2 + xZn$.

The phase rule will throw some light on the relationship between metal, nitride and gaseous nitrogen. If we have three phases, liquid metal, solid nitride and a gaseous phase ($p = 3$), and two components, zinc and nitrogen ($N = 2$), then

$$F = N + 2 - p$$
$$= 2 + 2 - 3 = 1$$

That is to say, there is one degree of freedom. When

the nitride has a certain nitrogen pressure, equilibrium will be attained when this pressure corresponds to a definite temperature, and the concentration will adjust itself simultaneously.

If, however, the nitride is dissolved in the liquid zinc, then the number of phases is reduced to two, and F equals 2. Regarding the temperature constant, the pressure and concentration may change until the solution becomes saturated. Further formation of nitride will then cause the system to revert to monovariance. $F = 1$ is therefore valid only in case the nitride takes part in the reactions as an independent phase.

If, therefore, nitrogen is passed over finely divided zinc at 600 deg., as in the above-mentioned tests, nitride will continue to be formed until the nitrogen pressure of the mixture $Zn_3N_2 + xZn$ equals the partial pressure of the nitrogen in the stream of gas.

Zinc dust from an electric spelter furnace, as well as dust from an electric refining furnace, was next examined for nitrogen. It was shown that the spelter dust contained 0.34 per cent nitride, and the refined zinc dust contained 0.33 per cent nitride. It has been shown in *Chemisches Centralblatt*, 1911, vol. 2, that zinc dust generally contains 0.16 to 0.42 per cent nitride. Consequently it has been demonstrated that zinc reacts with any nitrogen which may be present in the retort, and nitrogen should consequently be kept out of the apparatus as far as possible.

Regarding the influence of sulphur, it may be mentioned that the zinc dust from an electric spelter furnace contained 0.95 per sent S, which was present in the form of sulphide. Prof. J. Vogt has shown that zinc sulphide is appreciably volatile at 1,400 deg. In an electric furnace the temperature may run so high, as the slag produced is ordinarily tapped liquid.

Now, if the zinc ore is poorly roasted, so that the charge contains sulphur, some sulphide will volatilize. It will accompany the gases in a finely divided state, and may provide condensation nuclei which will promote the formation of dust.

Summary

The results thus found may be summarized as follows:

1. The amount of dust (for a given temperature of the condenser) is greater the more dilute the zinc vapor.

2. When condensing zinc, the temperature of the receiver is of paramount importance, since zinc is appreciably volatile above its melting point.

In practical work, it is difficult to keep the temperature exactly at the melting point of the metal, and the tests confirm the idea (Tables II and III, Figs. 2 and 3) that it is better to keep the temperature rather a little above than below the melting point.

3. The zinc vapors should have as short a path as possible from the furnace to the receiver. The longer time the zinc vapors require in order to be condensed the more carbon dioxide will be formed, according to the equation $2CO = CO_2 + C$ and the greater the amount of dust.

4. Even small amounts of water vapor in the gases promote the formation of dust and the precipitation of zinc oxide in the channel leading from the furnace to the condenser.

5. As nitrogen reacts with zinc, the reducing agent should contain as little nitrogen as possible. Moreover, the apparatus should be as tight as possible in order to keep the air out.

6. The various materials going into the charge should contain as little sulphur as possible, as it may cause the formation of zinc sulphide, which may volatilize at electric furnace temperatures. Some zinc sulphide may also remain in the charge, so that in any case some zinc will be lost.

Organization of Employers in Germany*

THE employers in German industry were extensively organized even in pre-war days. The auxiliary service law[1] (*Hilfsdienstgesetz*), enacted at the end of 1916, which had for its scope the greatest possible exploitation of all the economic forces of Germany, was responsible for the creation of additional large employers' organizations. Since the termination of the war, organization of the workers and salaried employees has made phenomenal progress and the solidarity of the workers is pushing the employers toward the utmost limits of financial concessions without securing afterward any compensation by way of increased or improved production. It is therefore not to be wondered at if employers' organizations have increased in numbers during the last two years and show a great tendency to combine in powerful national central organizations (*Reichsverbände*) so as to be able to resist in closed ranks the ever-increasing demands of the worker. Constantly repeated wage fights have created an atmosphere of bitterness, and since the fight has been transferred exclusively into the material domain employers' and workers' organizations face each other with an alarming incapacity for comprehending the true nature of problems for which a solution ought to be searched in common.

Division of the Organizations

German employers' organizations may be divided into four groups, according to whether they chiefly concern themselves: (1) With general economic and political problems; (2) with general socio-political problems; (3) with the regulation of special business interests (regulation of production, sales, or prices); or (4) with the safeguarding of the special interests of the employers in their relations with the workers (regulation of working conditions, especially of wages and hours of labor). Some employers' organizations include among their activities several or all of the four tasks enumerated. Employers' organizations are organized by industry groups as national, state, district or local.

Statistics on the Organizations

The latest official statistics on employers' organizations published by the German statistical office cover the year 1918 and are very incomplete owing to conditions prevailing during the war.

Statistics covering the year 1915 show that 3,683 employers' organizations were in existence in Germany in that year. Of these, 125 were national organizations, 499 were state or district organizations, and 3,059 were local organizations. Of the total number of organizations 1,920 reported a total of 156,938 members and 1,366 organizations reported the number of workers employed by their members, the tabulation of which

*From *Monthly Labor Review*, vol. 12, No. 3, March, 1921, p. 129.
[1]See *Monthly Labor Review*, April, 1918, pp. 89-103.

resulted in a total of 4,281,477 workers. By the end of 1918 the number of national employers' organizations had increased to 839, the following industry groups having the largest number: Commerce, 149; metal-working industries, 141; textile industry, 86; clothing industry, 56; quarrying, stonecutting, excavating, etc., 51; chemical, 51; paper, 51.

National Federation of German Industry and Union of German Employers' Federation

The strongest national organizations are the National Federation of German Industry (*Reichsverband der Deutschen Industrie*), founded in Jena on Jan. 12, 1919, through the consolidation of several large organizations covering various industry groups and intended as a solidary central organization of German industry for the representation of its political and economic interests, and its counterpart, the Union of German Employers' Federations (*Vereinigung der Deutschen Arbeitgeberverbände*), which deals with all social and socio-political problems of the German industry. One hundred and thirty national federations were affiliated with the latter organization in January, 1920. The number of workers employed by the members of these affiliated organizations is given as exceeding 4,000,000. The union has strongly opposed all attempts of workers' organizations to secure for the workers a share in the management of the establishments and was largely responsible for the mild form given to the German works' council law, believing that increased production is absolutely necessary for the economic reconstruction of Germany and that increased production can be achieved only by an independent employers' class and the development of free initiative by the employers.

At the last annual meeting of the Union of German Employers' Federations (March 11, 1920, at Berlin) its secretary pointed out "that a large number of social problems are awaiting solution, but that the union should for the present center all its activities upon the solution of the wage problem, the adjustment of prices, and consequently also of wages to world's market prices, the building up of a wage system based on the cost of living, the introduction of sliding wage scales, consideration of the size of the family of the worker in the fixing of wages, etc.; that a clearly defined policy of the employers' federations with respect to these problems requires thorough investigation of existing conditions and their effects; that the principal task of the German employers' federations must be energetic co-operation in reconstructing a basis for efficient production. They must create the conditions which make the performance of work possible and must oppose unjustified attempts to disturb and hamper peaceful production. To strengthen and support them therein through the power of combination must now as before be the task and aim of the Union of German Employers' Federations."[2]

Other Organizations

The Hansa Union of Trade, Commerce and Industry (*Hansabund für Gewerbe, Handel und Industrie*), one of the most reactionary employers' organizations of Germany, which has always maintained the point of view that the employer must be "master in his own house," has for a long time cherished the idea of forming a superunion of all German employers' organizations. This idea has in part been realized. According to *Soziale Praxis* (Berlin, July 21, 1920) some of the large national employers' organizations have combined into a Central Committee (*Zentralausschuss*). This central committee has proclaimed as its aim the solidary safeguarding of the common economic and political interests of all German employers and a concerted defense against all movements directed against these interests. A subsequent issue of *Soziale Praxis* (July 28, 1920) states, however, that the formation of this superunion has not been greeted with general acclaim. The fact is that German employers are already much overorganized. For this reason the National Federation of German Industry and the Union of German Employers' Federations have declined to become members of the new Central Committee. These two organizations are much stronger central organizations of employers than the new creation of the ultraconservative Hansabund can ever expect to become.

Power of the German Employers' Organizations

During the present critical industrial and labor situation the German employers' organizations schooled through long experience and welded together in the fire of revolutionary wage movements will give proof of their great power. The Union of German Employers' Federations is strongly prepared for defensive action, as has become evident from a secret circular letter addressed to its members. This circular letter, which somehow came into the hands of some labor organization and was given wide publicity in the labor press, deals with the attitude to be taken by the employers toward the works' council law of Jan. 18, 1920. The letter states that "the plans for a general strike of employers against the enactment of the works' council law have not been carried out, owing to reasons of expediency. It is also not intended to use sabotage against the law. Employers are, however, urgently requested to adopt a strong defensive attitude in the application of the law against all attempts to go beyond the letter of the law made either by the regulations for the enforcement of the law or by the workers. Employers are especially admonished against making concessions in the application of article 62 of the law.[3] In the framing of shop regulations (*Arbeitsordnungen*) and in the conclusion of collective agreements employers' federations should not go beyond the bounds of legal obligations." It can only be hoped that this warning will not prevent employers from working in harmony with sensible works' councils, however great the difficulties that are to be overcome while this new German institution is in its experimental stage.

In connection with the subject of employers' organizations it should be mentioned that following the amalgamation of German employers' federations the seventeen existing employers' societies for insurance against strikes formed themselves into one society under the name of German Protective Association Against Strikes (*Deutscher Streikschutz*).

(An article on "Organization of Workers in Germany" will be published in a subsequent issue.)

[2] *Soziale Praxis und Archiv für Volkswohlfahrt*, Berlin, May 5, 1920, p. 728.

[3] Article 62 of the works' council law has the following wording: "A works' council shall not be created, or, if already created, shall be dissolved if, in the nature of the establishment, there are special difficulties in the way of its institution or functioning and if by virtue of a collective agreement declared to be universally binding some other form of representation of the employees of the establishment exists or is to be set up. This form of representation shall take over the rights and duties assigned to the works' council by the present law. . . .

GENERAL VIEW OF THE JONES & LAUGHLIN STEEL CO.'S BYPRODUCT COKE PLANT

Byproduct Coke Plant of the Jones & Laughlin Steel Co.

A Summarized Description of the Installation and Operation of a Standard Koppers Coke Ovens Plant at Hazelwood, Pa., Capable of Coking Under Normal Conditions 5,000 Tons of Coal Per Day

By C. R. MEISSNER

THE byproduct coke plant of the Jones & Laughlin Steel Co. of Pittsburgh, which has now been in operation for nearly two years, includes many new developments in coking and byproduct recovery technique, making it one of the most up-to-date and efficient plants in the world.

The new plant comprises 300 ovens, in five batteries of sixty ovens each. Four of these batteries were built and put into operation first, the fifth being added about nine months later. Construction work was begun in May, 1918, and carried to very rapid completion under stress of war-time demands. The first three batteries started pushing coke in June, 1919, a year after ground was broken, and the fourth was started up in the following September. The fifth battery, of the new triangular-flued design, was started in March, 1920.

As normally operated the plant cokes about 5,000 tons of coal per day.

The entire byproduct coke plant was designed, constructed and put into operation by the Koppers Co. of Pittsburgh.

The plant is located along the Monongahela River at Hazelwood, and practically all coal is received direct from the company's mines. The coal as received is crushed to 4 in. at the mines. The roll crushers at the coke plant are designed to reduce to ¾-in. if desired.

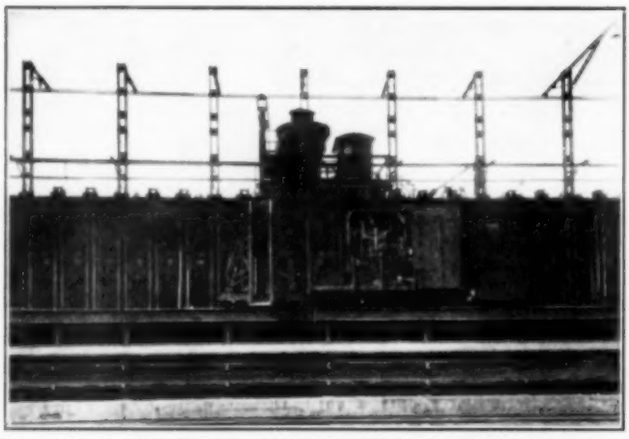
Ovens

There are three batteries in one row placed parallel with two in the other unit, their discharge sides facing each other. A 3,000-ton coal bin located over each row supplies the coal to the larry cars. Each of these bins is divided into two compartments to allow for cleaning out or repairs without interruption of coal supply.

The ovens are of the standard Koppers cross-regenerative type. The inside dimensions are: length, 37 ft. between doors; height, 9 ft. 10½ in.; width, tapering from 18⅛ to 15⅞ in. from coke discharge sides to pusher side. When coking straight high-volatile coals, it has been found of decided advantage to use a narrower oven chamber than that used for coking mixtures with lower-volatile coals.

The larry cars are built with four separate conical hoppers, above which are placed the measuring cylinders. By this method the ovens are always charged to constant volume regardless of weight, due to fineness of coal or moisture, uniformity and regularity being two requisites of good operation. Each larry car is also weighed as a matter of record. Telescopic, adjustable cylinders or sleeves are provided around each of the larry car hopper chutes, which are operated by a handle in the operator's cab. These are lowered to the oven brickwork during charging to prevent coal spillage around the charging holes. A motor-driven metal swab is provided on each larry car for cleaning out carbonaceous deposits in the gas off-take pipes when necessary.

Steam ejectors, provided in the gas off-takes from each oven, are used during charging to draw the first gas into the collecting main and thus prevent its loss

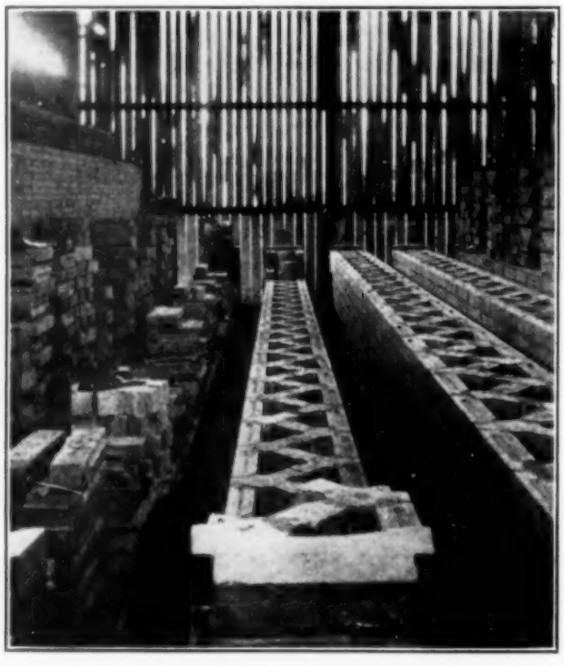


VIEW OF OVENS, SHOWING COAL LARRY, DOOR EXTRACTOR AND COKE GUIDE

to the air through the charging holes, thereby increasing the byproduct yield and making working conditions better for the men.

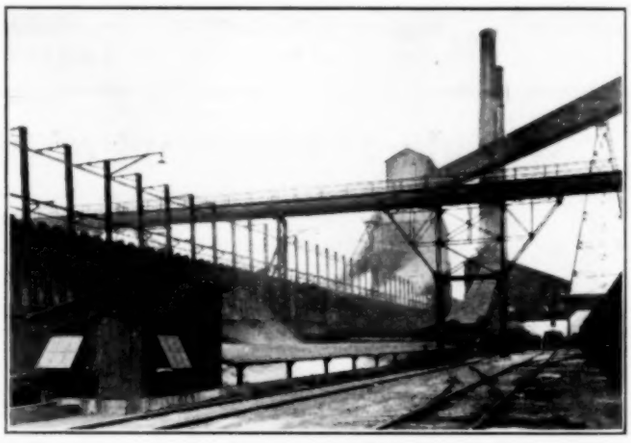
The first four batteries are built up of standard ovens having the well-known rectangular vertical flue construction in the heating walls. In the fifth battery, however, the heating walls are constructed according to the improved triangular flue design.

In this new type of construction the division walls between the heating flues are made diagonal to the plane of the oven walls, which gives the flues a triangular cross-section. Thus we have two sets of flues in each wall facing in opposite directions toward the adjacent ovens. Similarly each oven has practically its own independent set of heating flues. The overlapping arrangement makes it possible to supply fuel gas from a common header centrally located below the flues; or, in case producer gas is used, through ports from the gas regenerators. There are, however, two separate horizontal flues; one being located at the top of each set of vertical flues for carrying off the products of combustion. Practically independent regulation for each oven is attained by this arrangement. The accompanying photograph of a battery of triangular flue ovens during construction gives an idea of the flue arrangement. Compared with the rectangular flue construction, this triangular flue development involves no increase in the width of the oven wall, no increase in weight of brickwork and no additional investment per oven.



BATTERY OF TRIANGULAR FLUE OVENS DURING CONSTRUCTION

There are obvious mechanical advantages in this new construction as compared with the rectangular flue type. The triangular bracing gives a much stronger wall. Theoretically this increase in strength as regards lateral pressure is 33 per cent. Actual test models have shown an advantage of 30 per cent. Due to the overlapping arrangement there are forty-four flues in the new wall as compared with thirty in the former type. This tends to give greater uniformity of heating. The faces of the flues adjacent to the oven wall are wider and thus the liner brick are longer, resulting in a 22 per cent decrease in the number of joints in each wall. Less opportunity is thus provided for gas loss outward or air leakage inward and the wear and tear during regular operation are materially reduced.



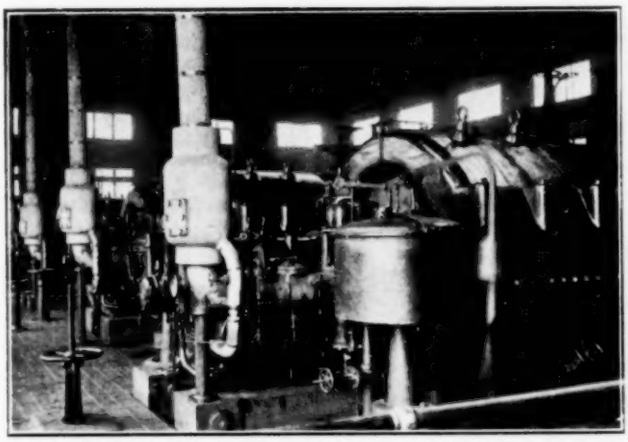
OVENS, QUENCHING CAR, COKE WHARF AND SCREENING STATION

The operation of the triangular flue type of ovens has proved so satisfactory that the Koppers Co. is installing them in several new plants.

Coke Handling

At the quenching stations the drainage water is passed through settling basins and recirculated, river water being used to make up for evaporation. More or less fine sediment, mostly coke breeze, settles in the spray pipes and tends to give trouble due to blocking up the holes from the inside. In order to facilitate the removal of this sediment quick opening valves have been provided at both ends of each spray pipe. Regular flushing out obviates all stoppage troubles. The moisture is readily controlled. Hot coke spots are quenched on the wharf by means of hand hose connections.

All coke-handling apparatus is arranged in duplicate between the two rows of batteries. Ample coke wharf space is provided for each unit of batteries. One wharf will hold eight, the other ten oven charges, so any ordinary delays in the coke-handling system or in spotting cars need not disturb the oven-pushing schedule, which is maintained with iron-clad regularity. A small auxiliary wharf is provided to handle run of coke direct to cars over a separate conveying system in case of any serious trouble in the regular system. The two screening stations are separate and independent,



GAS EXHAUSTER WITH REINFORCED CONCRETE CASINGS

loading cars on parallel tracks. The screens are of the bar grizzly type, set at 28 degrees, each made up of forty-eight bars wide and six sets long, spacing ¾ in. The bars are 2 ft. long and the spacing is wider at the bottom than at the top of each set. The bars are made wedge-shaped in section, giving an opening flaring out at right angles to the screen surface. This construction prevents coke pieces from wedging between the bars, making the screens self-cleaning. The increased spacing of the bars as they wear out is taken care of by replacements. Coke cars are at present spotted by steam locomotives, the movements of which are regulated by electric signals from screening stations.

Gas-Collecting and Cooling System

The gas-collecting and byproduct-recovery system is of the standard Koppers design. The pressure on the collecting mains is maintained at an average of 2¾ mm. water gage. By carrying this pressure in the collecting mains, the pressure in top of oven is zero, the same as in the top of the heating flues. Butterfly valves controlling this pressure are located in each of the two suction mains from each battery. These valves are controlled by governors, some of the standard Northwestern type and some of the hydraulic type. Pressure variations affect a float in the usual manner, but this float operates a small hydraulic valve mechanism, which in turn controls the water flow to the operating piston cylinder. Operation is very smooth, positive and also very sensitive. Butterfly dampers are used in the gas off-take goosenecks to cut off the ovens from the collecting main. They are very easy to operate, light deposits of carbon making them fit gas tight, thus proving very satisfactory.

The collecting and suction mains are flushed with a mixture of 40 per cent tar and 60 per cent liquor, this mixture being quite closely controllable by a suitable arrangement of valves and piping at the flushing or hot drain tank. Such a mixture has been found most satisfactory for maintaining clean mains and for cooling the gas. Gas reaches the primary coolers at about 75 deg. C. After the coolers, it is carried at 28 deg. to 30 deg. C. Lower temperatures than this tend to throw down more light oils into the tar than is desirable.

Concrete Exhausters and Boosters

Due to the shortage of steel during the war period in which the plant was built and to the difficulty in obtaining deliveries, it was necessary to economize on metal where possible. To avoid several months' delay in securing casings for the centrifugal gas exhausters and boosters, they were constructed of reinforced concrete. They resemble the steel shells in all outward appearances. The base is cast integrally with the foundation. Cast-steel flanges are cast in to make connection with similar flanges on the upper section and to carry the bearing boxes. The top sections are entirely of concrete cast in one piece with steel flanges and eye bolts complete. These machines are giving entire satisfaction under all plant operating conditions. Concrete has previously been used for mine fan casings, but this is believed to be its first trial for high-speed centrifugals, pumping raw gas. The concrete turbo blowers were constructed on the ground by the Koppers Co. under direction of General Electric Co. engineers.

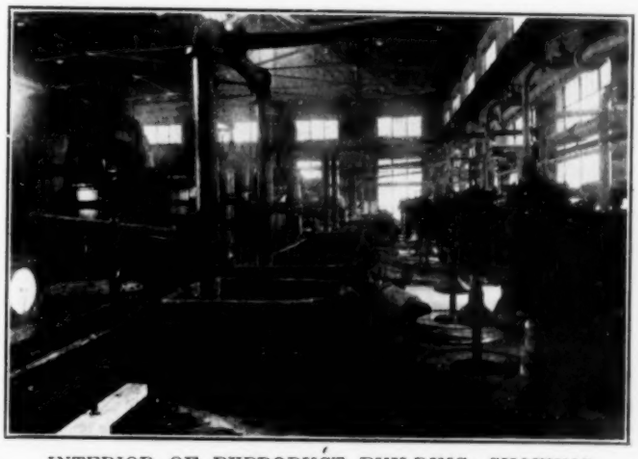
Byproduct Recovery Apparatus

The P. & A. tar extractors are equipped with Tagliabue controls to maintain a constant gas pressure differential by raising or lowering the level of the tar seal. A differential pressure of 6-in. water is normally maintained. As the centrifugal exhausters remove about 75 per cent of the tar remaining in the gas after the primary coolers, the tar extractors function in the removal of the last traces of tar fog. The reheaters are not regularly used but only as required by saturator conditions. This is due to the use of 66 deg. Bé. sulphuric acid. The heat of reaction is sufficient to maintain the bath at a proper operating temperature to evaporate water used in washing salt, etc.

The saturators are of the Koppers large elliptical design with two ejectors and two drain tables feeding to three centrifugal driers. Dried salt is wheeled in buggies and after weighing on a suspended platform scale is dumped into a pit. From this it is periodically removed by an overhead electric traveling crane and bucket and dumped into the stock pile.

Tar-Flushing System and Ammonia Still Waste

All condensate from the primary coolers, exhausters, tar extractors, etc., is run directly into the suction of the flushing pumps instead of into the hot drain tank, to be pumped back over the collecting mains. This is done to allow some redistillation of the light oils by the hot gas in the mains, thus cutting down the amount going into the tar and allowing a larger recovery by the light-oil scrubbers. All return flushing from the collecting and suction main goes direct to the hot drain tank. Motor-driven centrifugal tar and liquor pumps are used



INTERIOR OF BYPRODUCT BUILDING, SHOWING AMMONIUM SULPHATE APPARATUS

regularly. A small boom derrick with clamshell bucket is provided for cleaning out the hot drain tank and still waste sump, being located between the two.

The lime sludge from the sump is being successfully used by mixing with the mud used for luting the oven doors. It is said to improve materially the consistency of this mud and at the same time dispense with the loam requirements.

Light-Oil Recovery Plant

There are two final coolers 80 ft. high and 14 ft. in diameter, having the same interior construction as the scrubbers, being fitted with wooden hurdles. The four scrubbers are 100 ft. in height and 18 ft. in diameter, and are placed in parallel sets of two each. The gas is evenly divided through the two sets of apparatus.

Distribution of Gas

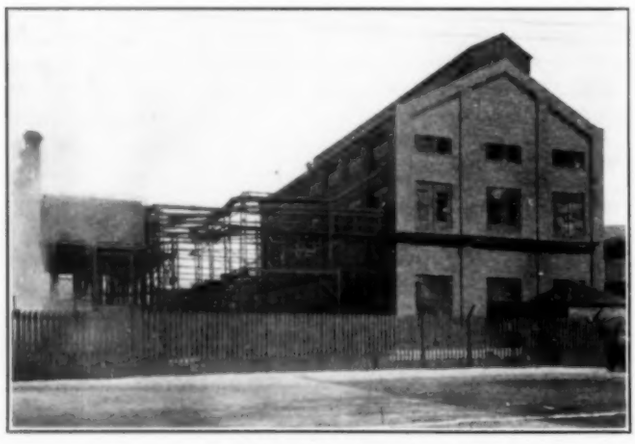
The final cleaned gas after leaving the light-oil scrubbers goes to a 40,000-cu.ft. holder. The surplus gas is used in heating furnaces, soaking pits, etc., to replace natural gas formerly used. Total and surplus gas is measured by Venturi meters which give very close and satisfactory results. When the mills do not require the gas, as on Saturday afternoon and Sunday, it is burned in the boiler house or bled to the atmosphere in extreme cases.

Boiler House

The boiler house contains eight B. & W. 500-hp. boilers equipped with Coxe stokers and Dietrich flat suspended arches. Coke breeze is burned normally, and practically all of the plant production of this material is thus utilized. Breeze is dumped from hopper cars to a pit and thence handled by an overhead crane to the feeder bins at the boilers. Ashes are dumped from hand trucks into an adjacent pit and handled by the same crane to cars for removal.

Benzene Plant

The benzene plant embodies many improvements. Heat exchangers, vapor to oil, are mounted directly on



BENZENE BUILDING

top of the light-oil stills in a vertical position. The superheaters are of the high, upright, cylindrical type. All light-oil and benzene vapor coolers and condensers are of the open coil with outside water spray type. They are located outdoors directly over the wash oil coolers of the same type, thus conserving water.

The crude and pure stills are each of 15,000 gal. capacity. There are three crude and four pure stills, the only difference being in the greater height of the rectifying columns on the latter. Motor fuel, pure benzene and toluene are run off as the market dictates.

Acid-Regenerating Plant

The crude fractions are washed in a separate building located at some distance from the benzene plant. The two agitators are set high in a steel framework and sludge is drained directly into four acid-regenerating pots located below and to one side, but well above the yard level. These pots are of the tilting type with stationary sand-sealed covers. The final spongy sludge mass is dumped directly into large wooden boxes set on a flat car. These boxes are equipped with steel hooks so they can be lifted and emptied by a locomotive crane.

Synopsis of Recent Chemical & Metallurgical Literature

The Edible Vegetable Oil Industry.—A concise outline of the edible vegetable oil industry by H. Tefft was published in the April issue of *Canadian Chemistry and Metallurgy*, p. 102.

Vegetable oils may be divided into two classes, domestic and Oriental. The domestic oils (produced on the North American continent) include cottonseed, linseed, peanut, castor, corn and sunflower. The chief Oriental oils are coconut, palm, palm-kernel, soya-bean, rape-seed and peanut. The Philippine and South Pacific Islands and the Malay Archipelago are the big producers of copra and coconut oil. Palm oil and palm-kernel oil come chiefly from Africa; soya-bean, rape-seed and peanut oils from China.

These oils may also be classified as edible or commercial. Divided in this manner, the commercial oils used for manufacturing some inedible product such as paint would be linseed, castor and rape-seed. The edible oils would include cottonseed, peanut, corn, sunflower, coconut, palm, palm-kernel and soya-bean. Some of the oils are in both classes.

There are three general methods of obtaining the edible oils—extraction, expeller pressing and hydraulic pressing, or combinations of these methods. The exact procedure varies according to the individual characteristics of the oil. In the case of peanut oil, the peanuts after being shelled, blanched and degermed are given a preliminary pressing in an expeller press, the product being a virgin oil which is capable of being used for edible purposes without further treatment. The cake from the expeller press is then ground, cooked and put through a hydraulic press to obtain the remaining oil.

For refining the crude oils, the method almost universally employed is to agitate the oil with a solution of caustic soda, allow the resulting soap to settle, and siphon off the supernatant oil. This procedure neutralizes the acid in the oil, coagulates the albuminous material and, in settling, drags down what meal or other foreign matter there may be in the oil. A certain amount of the original color is removed at the same time. After being siphoned off, this neutralized oil is clarified by further settling and is then mixed with some bleaching agent such as fullers earth or filt-char and pumped through a filter press. The oil is then run into a deodorizer and blown with steam at a high temperature. For salad oils, a mild-flavored oil is refrigerated to separate stearine, which is then removed by filtration.

Modifications of the caustic refining treatment include the Chisholm process, in which sodium silicate is added to the caustic soda, and the Baskerville process, using cotton linters with the caustic, a percentage of soda ash being added before removing the foots in a filter press. The foots

or settlings from the refining process consist of neutralized fatty acids, coagulated albuminous matter, dirt and other inpurities, precipitated coloring matter, saponified oil, and unsaponified oil entrained in the foots. Formerly, foots were either pumped to a tank car or cut with sulphuric acid to form "black grease." In either case, their destination was the soapmaker. Recently it has been found that by diluting the foots with water and passing them through a Sharples supercentrifugal, a certain proportion of the entrained unsaponified oil can be recovered. This process is one of the most important improvements in the old method of refining that has been developed in recent years.

The hydrogenation process has also had a wonderful influence upon this industry. For one thing, it has made the soap manufacturer independent of the supply of harder fats, as he can buy softer oils and harden them according to his needs.

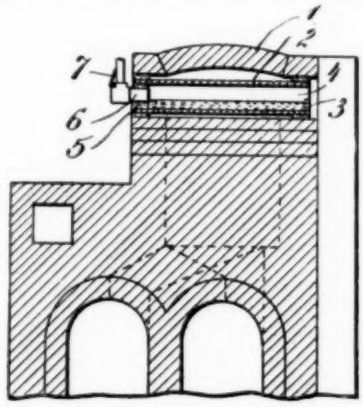
There are unlimited opportunities for research in this field. The action of fullers earth and caustic soda, the disagreeable flavors and odors in the oils, the exact mechanisms of the various reactions which take place—all these require careful study. Often an oil is received at the refinery which defies all efforts to obtain concordant results either in the laboratory or the factory, in spite of the greatest care in handling. There are apparently some variable factors which cannot be brought under control at present because they are not thoroughly understood.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

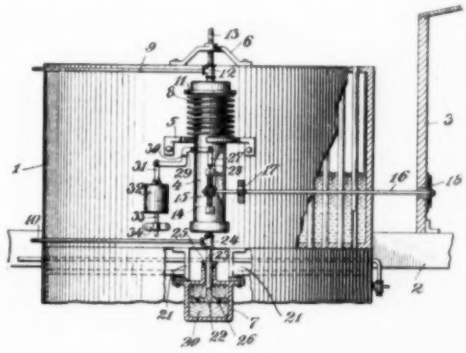
French Process Zinc Oxide.—In the production of French oxide by the retort volatilizing process it is the common practice in the art to charge the retorts with broken up slabs of zinc, which must be melted and brought to the volatilizing temperature before the oxide production can take place. The production of French oxide in this way is an intermittent operation, each charge being worked off before the next charge is introduced into the retort. As a result the retorts can be operated at their maximum capacity during only a part of the time. This intermittent method of operation requires frequent cleaning of the retorts, while the retorts themselves not infrequently crack



or fail and must be replaced, thus further decreasing the output of the furnace and increasing the labor and expense of operation. So also such intermittent operation of the retorts is wasteful of fuel for the reason that the retorts must be heated during the time interval between the end of one operation and the beginning of the next, as well as during the preliminary period of melting the zinc and heating it to the required temperature, and also during the entire working-off operation, during the latter part of which the retort is operated at a greatly reduced capacity owing to the progressively decreasing amount of molten zinc remaining therein.

In order to make possible continuous operation JAMES A. SINGMASTER of Palmerton, Pa., proposes to maintain an approximately constant amount of zinc in each retort by adding molten zinc from time to time. For this purpose an auxiliary melting furnace is supplied with metal from the spelter furnaces. A later improvement by WALTER L. COURSEN is to cast the zinc in small rods, which are placed in the retorts at intervals. In either case the level of molten metal in the retorts is kept practically constant so that even when lead is present the retort may be operated for a long time before the concentration of lead becomes great enough to cause trouble. The accompanying illustration represents a vertical transverse section of a retort furnace. The retorts 2 (of which there are twenty in each furnace) have the usual dam 3 at one end and the usual opening 4 above it and are closed at the other end by a closure or luting 5, through which extends the pipe 6. The retorts are heated externally to a temperature above the volatilization point of zinc but below that of lead, iron, etc., and the retorts are kept filled with a reducing gas, such as clean producer gas, introduced through the pipe 6. The introduction of this gas prevents premature oxidation of the zinc vapor and also assists in sweeping out the zinc vapor as fast as formed. The zinc vapor and the producer gas combine with the oxygen of the air at the mouth of the retort, and the oxide thus produced is collected in the usual way. For use with the present inventions doors 7 are provided in the ends of the pipes 6. Through these the molten zinc or rods may be added to the retorts. (1,372,462 and 1,372,486; assigned to the New Jersey Zinc Co.; March 22, 1921.)

Apparatus for Indicating the Height of Liquids in Receptacles.—Referring to the figure, the gaging device comprises a weighing cylinder 4 supported in position adja-



cent the boiler 1 by suitable brackets 5 and 6, and a dashpot 7. The weighing cylinder 4 is yieldingly mounted upon a calibrated spring 8 and has communication with the interior of the tank by means of the pipes 9 and 10, which are of sufficient length to extend around the tank to a point diametrically opposite the position of the weighing cylinder. The pipes 9 and 10 by reason of their length flex readily and avoid exerting any appreciable restraint against the free vertical movement of the weighing cylinder under conditions of operation. The calibrated spring 8 surrounds the weighing cylinder 4 and is interposed between the bracket 5, which is made fast to the exterior of the tank 1 and a flange 11 formed on the top cap of the cylinder 4, so that the weight of the cylinder and its contents will be carried by the spring, the whole exerting a compressive tension against the spring. Extending from a union 12, which affords communication between the pipe 9 and cylinder 4, is a guide rod 13 loosely fitting within the bracket 6, which is riveted or otherwise secured to the tank forming an aligning means which confines the movement of the weighing cylinder to the vertical.

It will be understood from the description thus far that the liquid supplied to the tank 1 will flow without restraint

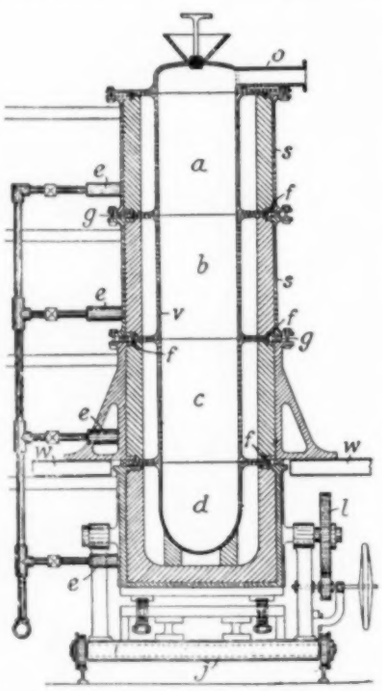
through pipe 10 into the weighing cylinder 4 and will rise therein to an equal level, causing the weighing cylinder to descend against the tension of the calibrated spring 8. In order to indicate the level of the liquid entering the weighing cylinder 4, and hence the level of the liquid within the tank 1, the following instrumentalities are used. Upon the side of the weighing cylinder 4 is arranged a rack 14; co-operating with the rack is a pinion 15 mounted upon a shaft 16, the latter being guided by a bearing 17. This shaft has mounted upon its extremity an indicating hand 18, which co-operates with a dial 19, which is suitably graduated. It will be obvious that as the weighing cylinder 4 moves in either direction this motion is communicated to the hand 18, causing the latter to vary accordingly upon the dial. By suitably proportioning the parts such as increasing the size of the pinion 15 the extent of movement of the hand 18 over the dial can be governed.

The sensitiveness may be increased by the use of a counterweight which balances the weight of the cylinder. One means of accomplishing this result consists in using a link 27 pivoted to the weighing cylinder 4 at 28, to which link is connected a lever 29 pivotedly supported at 30. The opposite extremity of this lever is connected to a link 31 which supports a counterweight 32, having a projecting extremity 33 guided in a guide-bearing 34. (1,367,689; JOSEPH C. FULLER, of Sewaren, N. J.; Feb. 8, 1921.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Tungsten.—Tungsten powder is obtained from sodium or potassium tungstate or both by mixing the tungstate with a chloride, preferably ammonium chloride, and a reducing agent such as wood, charcoal, anthracite or sawdust, and heating the mixture in the form of briquets or otherwise to 1,000-1,500 deg. C. for about fifteen hours. The product is either cooled out of contact with air or is quenched in water. Any soluble tungstates formed may be precipitated with lime and calcium chloride and the calcium tungstate added to a subsequent charge. The furnace shown comprises a casing *s* and a retort *v* arranged in sections and heated by burners *e*, the joints between the sections being provided with asbestos packing *f* and spring washers *g*. The upper sections *a*, *b*, *c* are mounted on a platform *w* and the bottom section *d* in bearings on a carriage *j*, tilting means *l* being provided. As the charge is heated, it melts and sinks into the section *d*, ammonia which is evolved escaping through an opening *o* and being recovered for re-use. The chamber *d* is then disconnected and removed and the heating completed under a separate hood. According to the provisional specification, fluorides may be used instead of or in addition to chlorides. (Br. Pat. 155,600, C. J. HEAD, London; Feb. 23, 1921.)



Thioglycollates.—An aqueous solution of thioglycollic acid is treated successively with an aqueous solution of a silver salt and one of caustic soda; or the silver solution, for example silver nitrate or fluoride, may be added to the thioglycollic acid dissolved in caustic soda. By addition of alcohol, silver thioglycollate of sodium, $AgS\text{-}CH_2\text{-}COONa$, is precipitated as a yellow powder, which is soluble in water and is of value in treating gonococci diseases. (Br. Pat. 156,103; not yet accepted; CHEMISCHE FABRIK FLORA, Zurich, Switzerland. March 2, 1921.)

Assimilable Phosphates.—Phosphates are rendered assimilable as a manure by grinding them with a large quantity of water to which has preferably been added a small amount of acid or alkali. The finely divided phosphate becomes hydrated and assumes a colloidal-like form which after drying is equal in value to water-soluble phosphates. The addition of 0.1 to 3 per cent of sulphuric, nitric or phosphoric acid is sufficient to accelerate this transformation considerably. The process is facilitated by conducting it under pressure or by heating to about 90 to 95 deg. C., or by adding protective colloids such as tannin, salts of lysalbinic acid, or the alkali salts of humic acid. Bone-meal and guano may be subjected to the same process. In an example slag phosphate is first ground in a phosphate mill and is then disintegrated in the presence of six times its amount of water. The resulting suspension is weakly acidified with a gaseous or liquid acid and allowed to separate into two layers. The bottom layer of phosphate mud is withdrawn, filtered and dried; preferably by blowing with hot air or by heating with waste gases. (Br. Pat. 154,124; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 2, 1921.)

Zinc Sulphide—Lithopone.—Zinc polysulphide is obtained by precipitation of a zinc salt of an organic or inorganic acid such as zinc chloride with an alkali or alkaline earth polysulphide such as a barium polysulphide, while maintaining an excess of the zinc salt. The zinc chloride may be obtained by treating zinc sulphate with barium chloride, and the barium sulphate is reduced to sulphide, dissolved, and converted into any polysulphide by treatment with the requisite quantity of sulphur. Lithopone is obtained by precipitating zinc sulphate with barium polysulphide in presence of a soluble zinc salt or other than the sulphate. The precipitated zinc polysulphide is completely washed and dried and is heated first at about 300 deg. C. until any oxide present is converted into sulphide, the sulphur dioxide being removed, and then to about 700 deg. C. The heating is effected in a clay crucible and a current of inert gas such as nitrogen may be passed through. The sulphur expelled may be collected and used for making more barium polysulphide. (Br. Pat. 155,824; not yet accepted; FABRIQUES DE PRODUITS CHIMIQUES DE THANN ET DE MULHOUSE, Thann, France. March 2, 1921.)

Nitrocellulose Compositions.—Nitrocellulose is dissolved in non-volatile liquid tricresyl esters of phosphoric or thiophosphoric acid, or in halogen substitution products of these esters. The solution, with the addition of fillers and coloring matter, may be combined with one or more layers of fabric to form driving belts, floor coverings, etc., or may be molded under pressure into various forms for insulating and other purposes. A typical composition contains 20 to 25 per cent nitrocellulose, 28 to 35 per cent phosphoric acid tricresyl ester, 15 to 20 per cent chalk or fossil earth, 2 to 5 per cent English red, and 35 to 15 per cent finely ground sawdust. (Br. Pat. 156,096; not yet accepted; C. CLAESSEN, Berlin, March 2, 1921.)

Acetic Acid.—In the catalytic oxidation of liquid acetaldehyde to acetic acid the formation of peracetic acid is inhibited by using as catalysts salts containing water of crystallization—e.g., hydrated salts, particularly the acetates, of nickel, cobalt, manganese, chromium or copper, alkali and alkaline earth hydrated salts, and alums. Salts specifically mentioned are ferrous sulphate, sodium acetate, potassium cobalt sulphate, potassium ferrisulphate and manganous sulphate. According to the example, oxygen or air is passed into acetaldehyde containing finely divided ferrous sulphate ($FeSO_4.7H_2O$), the resulting acetic acid separated from the salt and then distilled, preferably in vacuo. The remaining ferric sulphate can be used afresh after it has been reduced and crystallized. (Br. Pat. 156,146; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 2, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Knox Dye Amendment Passes Senate

The Knox amendment continuing the control of the War Trade Board over imports of dyes was embodied in the emergency tariff bill in exactly the form as approved by the committee and the bill itself was passed May 11 by a vote of 63 to 28. The measure now goes to conference, where the differences between the Senate and House bills will be adjusted. It is practically certain that the House conferees will accept the Knox amendment. Senator Moses of New Hampshire, chief opponent of the amendment, declares that its adoption means that the licensing of dye imports not only will extend during the six months' life of the emergency tariff, but will be written into the permanent tariff bill as well.

Senator Moses Condemns the Measure

Senator Moses condemned the whole emergency tariff measure as "unscientific, unjust and sure to defeat the hopes of those who have advocated it." Embargo and licensing systems were condemned by the New Hampshire Senator as being un-Republican, un-Democratic and un-American. He said the amendment "puts hundreds of business men to the disadvantage of exposing the secrets of their business to some petty agent of the War Trade Board, which continues to function, though war long since has ceased." He condemned the dye industries for spending large sums in pushing the amendment when they "were hammering at the gates of Congress with the plaintive cry that they could not live out the winter." In that connection Senator Moses went into some detail as to the expenditures which he alleges were made by the American Dyes Institute in its effort to secure this legislation. He declared that Morris R. Poucher "is the Dyes Institute, is the du Pont company, is the Textile Alliance and it is now proposed to make him the doorway to the War Trade Board."

"In these various capacities," continued Senator Moses, "the way will be paved to him to know not only the details of the business of every dye manufacturer in the United States, but to secure an accurate line on the consumer as well—to whom he may dictate what he may and may not use. The dye consumers of the country may as well understand in the beginning that the entire dyestuffs business of the United States is to be turned over to Mr. Poucher and to those whom he represents and that they will determine who shall or shall not continue in business, whether it be manufacturing, importing or consuming."

Senator Moses pointed out that the word "dyestuffs" is new so far as American statutes are concerned. Since the word has received no legal interpretation, he expects that it will be interpreted to include not only the coal-tar colors but the natural dyes, such as logwood, fustic, natural indigo, prussian blue and the like.

Senator Knox Replies

Senator Knox, speaking on the floor of the Senate in defense of his amendment, declared that he had been amused by the arguments of Senator Moses, which he characterized as being prejudiced. "It is not my purpose," said Senator Knox, "to approach the consideration of the amendment from the standpoint of a profit and loss account of a Dolly Varden calico mill in New England, but from the standpoint of the roster of the dead of the great war." He stated that he would omit from his arguments the economic reasons for protecting the dye industry and would confine himself solely to the need for establishing a great chemical industry because of its importance for the national defense.

When the war began gas shells constituted an insignificant proportion of projectiles, Senator Knox pointed out, yet at the time of the Germans' last retreat it was found that fully 50 per cent of their projectiles were filled with gas rather than with high explosives. He quoted extensively from General Fries to bring out the importance of chemical warfare and the certainty that it will be employed in any future conflicts. He also embodied in his remarks certain observations of Colonel Phillippe Bunau-Varilla in speaking of the pre-war blindness of the French people in not meeting the German advance in organic chemistry, so as to be able to cope with them in the production of chemical armament.

Senator Knox had printed in the *Congressional Record*, as an adjunct to his speech, practically the entire address delivered by General Fries at the recent Chemical Warfare Service annual dinner. He also included, as a part of his remarks, a memorandum written by General Fries to General Leonard Wood in which was pointed out how easy it would be for Japan, in the event of war with that country, to take the Philippines with the aid of gas.

In the course of his remarks, Senator Knox called attention to the fact that in 1914 there were seven manufacturers of dyes in the United States. In 1920 there were 184 dye manufacturers in this country, which fact he used as an argument to show that the industry is not being monopolized by a few. He explained that necessarily some of these institutions must be great and must be enormously capitalized, since "when great things are being done in the world, it requires great instrumentalities to accomplish them."

General Staff College Hears of Chemical Warfare

That the General Staff of the Army is coming to regard chemical warfare with greater sympathy may be judged by the fact that General Amos A. Fries on May 11 appeared before the General Staff College and delivered an exhaustive address on the underlying fundamental principles of chemical warfare. General Fries' remarks covered thirty-one typewritten pages. In the course of his address he declared that chemical warfare is the most scientific of all methods of fighting and is the most universally applicable of all the methods of making war. The use of gas, he said, is just as fundamental as was the introduction of gunpowder.

"The World War opened the eyes of England, France and Japan, as well as those of the United States," said General Fries in the course of his address. "Each of them today is struggling to build up a great chemical industry as the very foundation of successful war." At another point in his speech General Fries said:

"A part of the strategy of peace is the card indexing of the man power of a nation divided into special groups. In one great group must come those who have a knowledge of chemistry and the chemical industries. That must be so worked out that if war should come on a moment's notice, within twenty-four hours thereafter every chemist could be given his job, jobs extending from the firing line to the research laboratory. And that is the task of the Chemical Warfare Service."

General Fries reiterated a point he frequently has made that there never has been a case in history where a powerful weapon ever has been abandoned once its effectiveness had been proved. For that reason, he said, "our Government today is giving most serious heed to the need of building up a great chemical industry in the United States. We have the raw materials. We need only the factories and the trained men that go with them. We need of course, in addition to the development of the coal-tar industry, a production of heavy chemicals such as chlorine, sulphuric acid and the like, all of which, however, are bound together by community interest in peace as well as in war."

Engineering Council Urges Patent Office Relief

Wholesale resignations are crippling the United States Patent Office to the point of disorganization and are creating conditions that threaten American industrial enterprise and invention, it was declared in a statement issued by the American Engineering Council of the Federated American Engineering Societies.

The Council, through its patents committee, of which Edwin J. Prindle, of New York City, is chairman, asserted that the situation had become almost intolerable and quoted the new Commissioner of Patents, Thomas E. Robertson, as saying that remedial legislation at the present session of Congress is necessary if results approaching disruption were to be prevented.

The Council appealed for support of pending patent legislation, which provides sufficient increases in salaries to check the exodus of employees from the Patent Office to private employment. In a little over one year, it was stated, 110 of the force of examiners numbering 437 have resigned. During the first three weeks of the Harding administration six highly trained experts quit to accept salaries two or three times as great on the outside.

In the past year, according to figures furnished by Commissioner Robertson, 142 of the 560 clerical workers have left the service. There are thirty clerks in the Patent Office who receive only $60 a month. They would get $1,100 a year under the new salary bill.

The Council also made public a statement from Major A. M. Holcombe, former chief of the patent section, General Staff, United States Army, urging engineers to aid patent legislation and saying that patents play an increasingly important part in proportion to the degree of specialization in industry.

Chairman Prindle stated it was the unqualified opinion of the important engineering, research and manufacturing associations of the United States that the scientific and industrial interests of the country were being jeopardized by Patent Office conditions. The National Research Council, the American Chemical Society and the National Association of Manufacturers were cited by him as among the organizations favoring Patent Office relief.

"With our patent system working normally," he said, "many inventions will be produced each year which in the aggregate will add so much to the income of our country that the returns from income taxes will be much larger with the Patent Office properly supported. To deny the Patent Office relief is not economy, but waste. The European countries, taught by the war, are already strengthening their patent systems. America must not lag."

Extensions by Anaconda Company

Anaconda's annual report for the year 1920 contains the following information on new experimentation, construction and operation of new departments:

Anaconda

Very little construction work was done at Anaconda during the year 1920, the principal items being the completion of the 50-ton phosphate plant, which was begun in the latter part of 1919, and the completion of the arsenic refining plant, work on which was begun at the same time. Both of these plants were operated in a very satisfactory manner.

The 50-ton phosphate plant treated approximately 1,500 tons per month of rock and produced about 900 tons per month of treble superphosphate, containing about 47 per cent available phosphoric acid. This plant is a pilot plant intended for developing the process of producing high-grade phosphate and demonstrating the marketability of the product. Plans are under way for the construction of a large commercial plant to treat 400 to 450 tons of rock per day, together with the necessary sulphuric acid plant.

The new arsenic-refining plant, the remodeling of which was completed during the year, contains two refining furnaces each capable of producing about 200 tons per month of refined arsenic. Toward the end of the year a baghouse was constructed to recover the fume from the gases leaving the arsenic plant. The entire system operated in a most satisfactory manner.

A small experimental plant for the production of liquid sulphur dioxide and an experimental precipitator for the precipitation of copper from sulphate solutions by means of liquid sulphur dioxide were completed and successfully operated during the year.

Great Falls

A very considerable advance was made during the year in connection with the treatment of zinc plant residue and baghouse fume, by making the fume and the residue into briquets and smelting the same in one of the old copper blast furnaces, which was remodeled for this purpose.

At the rolling mill a double six-die wire drawing machine, a nine-die wire drawing machine and a seven-wire strander were added to the plant.

At the ferromanganese plant considerable work was done during the year in the way of reconstructing the furnaces as they wore out. Two of the furnaces were rebuilt along new and improved lines and the electrode holders were very much improved. The plant for the last half of the year operated very satisfactorily, but as there was a decided falling off in the demand for ferromanganese in the middle of December the operation of the Great Falls plant was discontinued.

East Chicago

The electrolytic white lead plant of the Anaconda Lead Products Co., located at East Chicago, Ind., was put in operation on Jan. 25, 1920, and immediately, as is usually the case in new process work, weaknesses in equipment and plant design developed, which from time to time were remedied and will be completely overcome in the near future. The cellroom of the plant developed a greater tonnage than was expected, thereby throwing out of balance the filtering, drying and barreling departments.

The process operated satisfactorily, the grade of the product being excellent, establishing a new standard of whiteness for white lead. Construction and operation of the plant were seriously hampered by a scarcity of labor, which was remedied only toward the close of the year. The plant made an output of eighteen tons of white lead per day during the last month of the year.

Potrerillos

The experimental mill of the Andes Copper Mining Co. at Potrerillos was started Jan. 25, 1920. Various alterations were made to permit of thorough tests on the oxide ores by a leaching process, to be followed by sulphur dioxide precipitation and iron cementation. The leaching experiments carried on during the year indicated a consistent extraction of 92 per cent of the copper content in the oxide ores treated.

The sulphur dioxide plant has been shipped to South America and should be in operation early in the year 1921. In the meantime tests on similar ores have been made at Anaconda, Mont. These experiments have fully corroborated the results obtained originally in the 1-ton plant at Anaconda and warrant the expectation of a very satisfactory recovery from the ores treated.

Due to shortage of fuel, the mill was shut down in September, 1920, but will be started up early in the year 1921.

Mme. Curie to Visit Washington

Mme. Curie arrived in New York City on the Olympic May 11 and was entertained at luncheon by New York chemists on May 17. She plans to visit Washington, where, on the afternoon of May 20, President Harding will present her with a gram of radium which has been purchased as a gift to her by the women of the United States. On the same evening a meeting in her honor will be held at the National Museum, where Prof. R. A. Millikan will speak on the subject of "Radium." The following two days will be spent in visits and entertainment in Washington, including dinners in honor of Mme. Curie at the French Embassy and Polish Legation, a trip to Mount Vernon, attendance at the formal opening of the cryogenic laboratories of the Bureau of Mines and a visit to the Bureau of Standards.

Annual Meeting, Society of Chemical Industry

The following message from Sir William J. Pope, president of the Society of Chemical Industry, was published in the April 15 issue of the *Journal* of the society:

As has already been announced, the next annual meeting of the Society of Chemical Industry will be held in Canada, in response to a very hearty invitation extended by the Montreal Section; the formal meeting extends from Aug. 29 to 31, but our Canadian friends have expressed the wish that the party from Europe will arrive a few days earlier so that they may be shown some parts of Canada not included in the extensive official program now being compiled. It will thus be convenient if as many of the visitors as possible will travel with me by the Melita, which leaves Liverpool on Friday, Aug. 12, and arrives at Montreal on or after Aug. 22.

At the close of the business meeting on Aug. 31, the members will leave Montreal by a special train for a four days' triangular tour of eastern Canada, during which visits will be paid to the paper and pulp works at Grand Mere, the largest in Canada, to the carbide and synthetic acetic acid factories at Shawinigan, and possibly to the aluminum and magnesium electrolytic plants. Sept. 2 will be spent at Ottawa and the next two days at Toronto. A boat trip across the lake has been arranged in connection with a visit to Niagara and to the chemical works and fruit farms on the Canadian side of the river. Sept. 6 will be spent in an inspection of the electrochemical works on the American side of the Niagara Falls, and the party will then proceed by train to New York.

From Sept. 7 to 10 the party will co-operate in a joint meeting of the Society of Chemical Industry and its American Section and the American Chemical Society; it will visit the great Chemical Exposition which opens at New York on Sept. 12, and which will certainly be one of the most important exhibitions of the chemical industry which has ever been held.

During the critical period through which all branches of the chemical industry are at present passing, when old markets are falling away and must be replaced by new ones, it is more than ever essential that British industrial chemists should seize every opportunity of gaining acquaintance with the conditions which prevail in the British Dominions and abroad; only by personal visits and by the establishment of new friendships and fresh business relationships can our members hope to be able to raise our chemical industries to the position indicated for them by the history and the geographical environment of these islands. Our Canadian and American friends have intimated their desire to furnish uncommonly extensive facilities for the inspection of works concerned with every branch of chemical industry, and it is certain that similar facilities cannot be granted to private individuals traveling alone apart from an official party such as is now being formed. The Council therefore desires to urge the members of our society to make every effort to accept the generous invitation extended to us by our transatlantic friends; we are convinced that the maximum benefit to our society and to the chemical industries of Great Britain, of Canada and of the United States can only be derived by the attendance of a large British party at the coming annual meeting.

New Chemistry Building at Buffalo

The Greater University of Buffalo, Buffalo, N. Y., will soon break ground for the construction of its proposed new chemistry building on Main St., contract for which was awarded recently to the J. W. Cowper Co., Fidelity Building. The structure will be three-story and basement, of Colonial style architecture; the facade will be of Indiana limestone with smooth light buff trim. The building will be constructed in the form of an H, with wings at the north and south ends, facing the campus.

A complete metallurgical laboratory will be located in the basement, supplemented by a dental metallurgical laboratory and electrochemical laboratory. The lobby on the main entrance floor will be used as a museum; in the north wing on this floor will be an organic laboratory, 48 x 96 ft., while the south wing will be used as a reading room, library and recitation room; at the front of the building on this floor will be the offices for the professors, smaller laboratories and supply rooms. On the second floor, the north wing will be used as an organic chemistry laboratory, and the south wing arranged for a microscopic laboratory, recitation room and lecture hall. Three large class rooms will also be located on this floor. The north wing on the third floor will be given over to a post-graduate laboratory and quantitative laboratory; in the south wing two other laboratories will be situated. The front of the building on this floor will be used for an analytical laboratory, with adjoining water and gas analysis laboratories and electrolysis department.

The building will have a total of approximately 17,000 sq.ft. on each floor, and has been designed to accommodate about 1,200 students. It is estimated to cost about $400,000.

Development Work of the Bureau of Chemistry

The office of Development Work has recently been created in the Bureau of Chemistry of the United States Department of Agriculture to assist in the industrialization and commercialization of chemical processes and discoveries worked out in the laboratories of the bureau. The engineers in this branch will endeavor to design mechanical equipment to place the processes on a plant production basis and determine the manufacturing cost and market value of the products. The chemical discoveries relate to the utilization of waste agricultural materials for new purposes and to the deriving of new substances from farm products. One of the projects undertaken has been the production of sirup from sweet potatoes. The process as worked out in the laboratory has been very satisfactory and the engineers in the Development Division are now endeavoring to obtain data to assist in the establishing of a sweet potato sirup production industry if the scheme is commercially feasible.

Another project to be undertaken in the near future has to do with deriving furfural, cellulose flour and two grades of adhesive from corn cobs. Other lines of work following up closely the methods determined in the laboratory will be undertaken. The industrial contact for the bureau will be handled through this new division and the engineers will be called upon to maintain satisfactory industrial relations with the business interests of the United States.

In connection with this development work the United States Civil Service Commission will receive applications until June 21 for positions of associate development engineer at salaries from $2,500 to $3,600 a year, assistant development engineer at salaries from $1,800 to $2,500 a year, and junior development engineer at salaries from $1,440 to $1,800 a year. Appointees at annual compensation of $2,500 or less, whose services are satisfactory, will be allowed the increase granted by Congress of $20 a month.

Applicants will not be required to report at any place for examination, but will be rated upon their education, training, and experience, as shown by their own statements and by corroborative evidence, and upon published writings or theses submitted with their applications. They must qualify in at least one of eleven specified engineering branches.

The requirements for entrance to these examinations and other information in full, together with application blanks, may be obtained by communicating with the United States Civil Service Commission, Washington, D. C., or the secretary of the local board of United States civil service examiners at the post office or custom house in any city.

C.W.S. to Test Gas Bombs in Naval Aerial Warfare

In connection with the tests of aërial bombs to be conducted off the Atlantic coast June 21 the Chemical Warfare Service is planning to experiment on the effectiveness of poison gas bombs. Non-explosive bombs filled with brombenzylcyanide will be dropped on a ship carrying a crew provided with gas masks. It has been pointed out that the ventilating system of all warships is based on a suction system drawing air through tubes to every part of the vessel. This system would be the chief ally of an enemy gas attack, sucking the deadly gases into every nook and corner of the vessel.

New Jersey Chemical Society Meeting

In an address on "Scientific Preparedness," delivered before the New Jersey Chemical Society May 9, Prof. Marston Taylor Bogert pointed out the profound influence which the use of poison gas was bound to have upon the methods of conducting future wars. Since chemical warfare can be waged with materials prepared from such seemingly innocent sources as the chlorine obtained from salt brines, coke, ethyl alcohol from the fermentation of carbohydrates, and the nitrogen of the air, the problem of chemical disarmament is by no means a simple one. Considered from the defensive point of view the safest policy would seem to be one involving unceasing research and study on the methods of chemical warfare and the assurance of a permanent domestic dye industry through appropriate legislation.

At the conclusion of Prof. Bogert's speech a short business meeting was held. A resolution was adopted urging the passage of the emergency tariff measure with the Knox amendment covering dyes and chemicals. Dr. F. W. Zons reported that the final touches were being put on the Year Book. Arrangements have been made by the committee on chemical industry for a visit to the Procter & Gamble plant at Port Ivory, Staten Island, on Saturday, May 21. Members expecting to attend were requested by Dr. Traub to be at the Elizabethport-Staten Island ferry not later than 9:30 a.m. Following the election of new members C. L. Bryden announced that the society now had 704 members.

Nickel

The technical program was continued by John F. Thompson, of the technical department, International Nickel Co. He outlined briefly the chemical and physical properties and uses of nickel and its more important alloys, such as Monel metal. A consideration of the applications of nickel compounds, however, brings out the interesting fact that with the exception of electroplating the demand is very slight. The property of forming two sets of compounds having valences of 2 and 3 respectively is utilized in one form of storage battery and some processes for the manufacture of nickel catalyzers depend upon nickel componds. Research directed toward widening the field of application of these compounds has developed some interesting points. One of the most promising seems to be the use of nickelic hydroxide as a pigment for printing ink. It has an excellent bluish undertone and makes an ink which prints well. Furthermore, it can be bleached easily so that the recovery of newsprint is facilitated.

R. L. Suhl, also of the International Nickel Co., commented on the prevalent idea that the price of nickel compounds is too high to warrant use as indicated. He said that the price was due largely to the small output and that with increased demand the economies of larger production would result in a substantial lowering of the price.

Executive Committee of T.A.P.P.I. Holds Meeting

The first meeting held by the executive committee of the Technical Association of the Pulp and Paper Industry since the election of George E. Williamson as president took place at the Strathmore Inn, Woronoco, Mass., on Thursday, May 5, and lasted over Friday. There was a full attendance of members.

Much Constructive Work Transacted

It is safe to say that at no previous meeting of the executive committee of T.A.P.P.I. has so much work of a constructive character been transacted. Plans of a service committee for the conduct of group meetings of the association were adopted and arrangements made for the fall meeting of the association to be held under the joint direction of T.A.P.P.I. and the American Pulp and Paper Mill Superintendents' Association at Washington, D. C.; York and York Haven, Pa., and Philadelphia, Oct. 18, 19 and 20, 1921. Fred A. Curtis, of the Paper Section, U. S. Bureau of Standards, Washington, was named general manager of the meeting for T.A.P.P.I. and he will be assisted by Grellet N. Collins, of Philadelphia, and others. Owing to an expected attendance of upward of 500 members and an already extended program of mill visitations, etc., it was found necessary to curtail the entertainment features to some extent. It was arranged that trips to York, York Haven and Wilmington be made optional for Wednesday, Oct. 19. This curtails the session in Washington to one day, Tuesday, Oct. 18, but members could arrange to reach Washington on Monday, Oct. 17, and spend the day in seeing the sights of the capital.

New Standing Committees Named

Other business transacted by the executive committee included the appointment of standing committees of the association for the ensuing year, the adoption of a budget and passing on estimates of income and expenditures. On a request by the Cost Association of the Paper Industry for an investigation of depreciation in values of machinery and apparatus a special committee of the association will be named for the purpose.

Election of Members

New members have been admitted by the executive committee during and since the annual meeting as follows: Charles L. Cockroft, night foreman, Everett Pulp & Paper Co., Lowell, Wash.; Richard H. DeMott, manager, industrial development department, SKF Industries, 165 Broadway, New York; Robert S. Finney, secretary and general manager, McNamee Kaolin Co., 60 Broadway, New York; Charles L. Harpham, manager of manufacturing, F. C. Huyck & Sons, Albany, N. Y.; Harry M. Hooker, sales manager, Hooker Electrochemical Co., 25 Pine St., New York; Benjamin K. Hotchkiss, sales department, Hooker Electrochemical Co., 25 Pine St., New York; Harold G. Ingraham, construction engineer, Marathon Paper Mills Co., Rothschild, Wis.; Dr. Edwin A. Rees, chemist, F. C. Huyck & Sons, Albany, N. Y.; John O. Ross, president and general manager, J. O. Ross Engineering Corporation, 30 East Forty-second St., New York.

Generous Contribution to Vocational Education Fund

A generous contribution to the funds of the Vocational Education Committee is announced, the Champion Fibre Co., Canton, N. C., having recently sent in its check for $500. This sum comes at a time when it is greatly needed for the completion of the work undertaken by the Joint Vocational Education Committee of the Pulp and Paper Industry of the United States and Canada, and it is hoped that the good example of the Champion Fibre Co. will be followed by other firms that have not been previously heard from.

Chemical Club of Philadelphia After More Members

The Chemical Club of Philadelphia is arranging a campaign for increased membership. At present there are more than fifty members, representing about thirty chemical companies in the city. Recently elected officers for the coming year are: J. H. Stutt, du Pont Co., president; F. S. Havens, Atlantic Products Corp., vice-president; W. J. Thorn, Innis, Speiden & Co., treasurer; W. H. Davis, Harshaw, Fuller & Goodwin Co., secretary.

Obituary

C. H. Clarke, president of the Clarke Chemical Co., Denver, Col., died recently at his home in that city.

Ambrose Monell, president of the International Nickel Co. for fifteen years and a metallurgist of note, died on May 2 at Beacon, N. Y., where he was undergoing a rest cure in an endeavor to recover from nervous prostration which had endured for several months. He leaves a widow, two sons and two daughters. Mr. Monell was born in New York City in 1874, and was graduated from the School of Mines, Columbia University, in 1896. He was then metallurgical engineer and assistant to the president, Carnegie

Steel Co., during which time he patented the steel process which bears his name. His idea was to adapt the Talbot continuous open-hearth process to a stationary furnace without retaining a heavy bath of molten metal at all times. As now practiced by the Carnegie Steel Co., molten pig iron is poured into a furnace containing white hot scrap, whereupon the impurities are rapidly oxidized and join with the lime and ore on the furnace bottom. Most of the slag boils out a special slag notch, or is skimmed off. What is known as the "lime boil" lasts two or three hours longer. After an hour more for adjusting the carbon content the steel is tapped. As head of the International Nickel Co., Mr. Monell was signally successful. His name has become widely known by the exploitation of Monel metal, an excellent natural alloy produced directly from the company's Canadian ore. These sulphide ores are roasted, and smelted into matte, a mixture of copper, nickel and iron sulphides. The iron sulphide is then eliminated by blowing the molten matte in a bessemer converter, and the resulting copper-nickel sulphide reduced with charcoal. When America entered the World War, Mr. Monell was commissioned Colonel in the aviation service and immediately went to France to organize the flying service on that side. He commanded at one time the day and night bombing groups. As a result of the intense strain under which he labored, his health broke down, never to be recovered.

Personal

A. J. BARNEBL, JR., formerly with the Dorr Co., is chief mechanical engineer for the K. B. Pulverizer Co., New York City, which is designing equipment for pulverizing coal.

L. H. CHAMBERLAIN has been appointed Western sales engineer for the Schutte & Koerting Co., with offices at 72 New Montgomery St., San Francisco.

B. DUNGLINSON, chemical engineer of the American Chemical & Sugar Machinery Co., has transferred his activities from the Philadelphia district to the Chicago office, with headquarters at 1725 Transportation Building.

AARON FRIEDMAN, formerly with Cooper & Cooper, Inc., is now with the New Process Metals Corporation of Newark, N. J. He will erect and superintend a plant for the manufacture of metallic cerium and other rare-earth metals.

O. H. KOCH, one of the members of American Engineering Council's executive board, has just completed visits to member societies in New Orleans, Birmingham and Nashville. He reports that they are much interested in the activities of the Federated American Engineering Societies.

E. C. LANE, chemist at the San Francisco laboratory of the U. S. Bureau of Mines, has left for an extended Eastern trip. He will spend several months in the Mid-Continent and Eastern oil fields and visit the stations of the bureau at Bartlesville and Pittsburgh, and also the Washington office, returning to San Francisco during the summer.

C. W. MILLER, president of the Davison Chemical Co., Baltimore, Md., has returned from a trip to the pyrites properties of the company in the West Indies.

L. W. WALLACE, the executive secretary of the Federated American Engineering Societies, has returned to his office in Washington after a visit to Milwaukee, Detroit and Chicago. At Milwaukee he addressed the Society of Industrial Engineers on industrial leadership. At Detroit he spoke at the annual banquet of the local engineering societies. In Chicago he attended the meeting of American Engineering Council's committee dealing with the licensing of engineers. This committee, in view of recent legislation, has made certain changes in its model bill. These changes will be laid before the executive board of the Council at its June meeting.

A. B. WILSON has resumed his former position as metallographist with the Titanium Alloy Manufacturing Co. and is engaged in work in connection with the use of ferro-carbon-titanium in steel.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, May 16, 1921.

The heavy chemical market is strengthening up markedly, in spite of several declines in some items. Confidence throughout the trade is increasing after the long period of depression and it looks as though the pendulum is about to swing back. Business, however, is still far from normal, but the general attitude is much more hopeful, as steadiness is increasing throughout the general list. Even *caustic potash*, which has been consistently the weakest commodity in the market, is showing signs of firmness. The stand taken by leading manufacturers of the country's big basic products in reference to labor is a sign of decreased inflation of producing costs and assures healthier markets a little later in the year. The announcement of a lowering of discount rates by Federal Reserve banks in various parts of the country is significant that frozen credits are being thawed out. This is one of the brightest features that has confronted industry since the beginning of the year. It is also apparent that a reduction in freight rates will shortly be made and, altogether, developments are working toward a satisfactory end from a business point of view.

GENERAL CHEMICALS

Importations of foreign chemicals and the desire of foreign interests to compete in the American market are features of great concern to American producers. Higher prices were named for imported *nitrite of soda* and the market closed in a firm condition with the passage of the emergency tariff bill. This undoubtedly will prevent the keen state of competition which has existed between domestic and imported nitrite. Prices are decidedly firm on resale *caustic potash*, with the imported material, 88-92 per cent, offered at 6c. per lb. Consumers are taking a moderate amount of this material at the low prices and it is understood that the soap trade has taken large quantities. Prominent dealers offered *acetate of soda* for immediate shipment on the basis of 4½c. per lb. f.o.b. works. It is intimated that the figure might be shaded on a firm bid for a round lot. The present movement is quiet and small lot operations feature the market. Resale stock of *bichromate of soda* was quoted at 8c. per lb. in several directions ex-store N. Y., and while odd lots can still be purchased at 7¾c., it is doubtful if very much business could be placed below the outside figure. Inquiries are said to be confined mostly to 5 and 10 lot quantities. Second-hand prices on *caustic soda* are reported at $3.60@$3.65 per 100 lb. ex-warehouse and $3.75 f.a.s. steamer. The inquiry is irregular, with small lots attracting the most attention. Producers state they are placing a fair amount of business with the consuming trades and quoted the former range of 3¾@3½c. per lb., basis 60 per cent, f.o.b. works. Higher prices for *nitrite of soda* were named on spot and the market covered a range from 6½@7c. per lb. The advance was not accompanied by any radical activity. Consumers are taking small lots on the advance but did not appear eager to extend commitments. Imported *prussiate of soda* is showing strength in the open market and most sellers are not inclined to shade 12½c., while 13c. was named in several quarters. Offerings were not heavy but seemed sufficient to meet the current extent of inquiries. Occasional sales of light *soda ash* in bags went through at $2.10 per 100 lb. Barrels were held at $2.40@$2.50 ex-store N. Y. The scarcity of offerings is keeping the market in a firm position. Producers report sales at $1.62½@$1.72½, basis 48 per cent, f.o.b. works in single bags. *Dense ash* is held at 10c. per 100 lb. premium. An arrival of a few 100-ton lots of ash was noted from Liverpool. Sellers of the imported material asserted that all April shipments were made and that May delivery is moving steadily.

Spot sales of *formaldehyde* were reported at 14½c. per lb. by second hands. Quotations are heard from 14@15c. per lb. according to seller. Buyers are taking moderate quantities of this chemical for miscellaneous consuming requirements. The undertone of the *glycerine* market rules steady regardless of the small volume of trading. Sellers' views on the dynamite are 15@15½c. per lb., while c.p. glycerine was held at 17@17½c. The *alcohol* market is still in a disturbing state and competition is keeping prices soft. Supplies of *ethyl alcohol* are easy and prices range from $4.65@$5.25 per gal., according to quantity. Small lots of *denatured* moved in moderate volume and sellers are asking from 32@48c. per gal., depending on quantity and formula. There has been little change in *methanol* prices, which range from 75c.@$1.15 per gal., depending on grade. Factors in *fluoride of soda* report sales at former levels, with small lot sales continuing to feature the market. Quotations range from 12@13c. per lb. The market on *bleaching powder* is very unsettled in the absence of any marked demand and prices among resellers are very hard to place. Offerings f.o.b. works from second hands have been heard all the way down to $2.15 per 100 lb. Makers' quotations are given as $2.75 per 100 lb., but this figure has little meaning in the present market. Makers of *lead acetate* have kept their prices at former levels and are quoting the white crystals at 13@13½c. per lb. and the brown variety at 11½@12½c. per lb. Producers of gray *sal ammoniac* have reduced their prices and are now quoting on a parity with the imported material at 7¾@8½c. per lb. Imported white granular is quoted at 6½@7½c. per lb. American makers of white sal ammoniac are holding at 10@10½c. per lb.

Coal-Tar Products

On Wednesday, May 11, the Senate passed the emergency tariff and anti-dumping bill, retaining all amendments recommended by the Finance Committee, but rejecting those individually proposed. The vote was 63 to 28. It is expected to become law practically unchanged. There is no doubt now among leading interests that the long period of uncertainty that has been such a drawback to the coal-tar industry will automatically pass with the enforcement of this new legislation. The volume of trading during the past week was of little larger proportion and the inquiry in one quarter and another was reported as more active. Full-time operation is noted in several mills where the four days a week schedule has been in force since last November. The lower bank rate is accepted as a good sign and if efforts now being made to secure financial assistance from the banking authorities are at all successful, a steady improvement in foreign business is expected. Dyestuffs have been more actively traded in during the period and principal factors are firm in their views on prices. Swiss and German dyes have been arriving quite regularly and occasionally small lots are available in resale quarters. Intermediates have held quite steady with a few moving more actively, while some of the less important have shown little evidence of any improvement.

Reports from some quarters on *para-amidophenol* reflect an improving demand, although there is little in the line of buying for future needs. Supplies are readily available and prices steady with the base at $1.60@$1.70 per lb., and the HCl at $1.75@$1.80 per lb. *Aniline oil* varies according to seller, ranging from 20@25c. per lb. It is possible to do 32c. per lb. on *beta naphthol*, although producers' figures are 42@45c. *Dimethylaniline* is quiet and only small quantities are called for with prices at 42@55c. per lb., depending on seller and quantity. Supplies of *diphenylamine* are easy, but prices are steady at 60@70c. per lb., with trading in fair volume. The consuming demand for *metaphenylenediamine* is fairly good and prices are steady at $1.15@$1.25 per lb. Factors in most quarters report a regular supply of *toluidine* available while the demand is limited to small routine movement with prices ranging from $1.25@$1.35 per lb. Trading in *toluene* was shown only in small lots during the week. There has been no change in the price level at 28@31c. per gal., depending on quantity, although second hands might shade down to 27c. on firm business. The market for *xylene* shows little change from day to day, with a slight routine consuming demand. Supplies of the pure are quoted at 40@45c. per gal.

Vegetable Oils

Trading in *cottonseed oil* lacked snap and the undertone was rather heavy considering the favorable turn of events in Europe. Grains, provisions and cotton moved upward, but this caused hardly a ripple in the cottonseed oil trade. Export inquiry was dull, with domestic demand also quiet. The crude material was a shade easier at the mill, sales passing at $5@$5.05 per 100 lb. The inquiry for *linseed oil* was reported as fair, consumers showing some interest in both nearby and July-September contracts. The undertone was firmer and while crushers no longer offered raw oil for nearby delivery at 64c. per gal., it was intimated that firm bids might still be accepted on carlot orders. Crushers were asking from 65@67c. per gal. for May-June shipment, with July-August oil commanding 66@68c., according to sellers. The market for *chinawood oil* closed higher at 12 @12½c. per lb. in barrels, spot delivery. May shipment oil was held at 10¾@11c., with June quoted at 10½c. per lb. The Coast market for prompt shipment oil was quite strong at 11c. asked. Demand for *coconut oil* was less active, bids being below the market and no important sales going through. On the Coast Manila oil for May shipment was offered at 8¼c. per lb., sellers' tanks, although some holders were still asking 8¾c. Copra inquiry was fairly active, but the asking price was considered too high. Bids were noted for Ceylon copra at 5¼c. and Manila at 5c. per lb., c.i.f. N. Y. Crude *corn oil* in Chicago was firm, closing at 5½c. per lb. sellers' tanks, nearby delivery. Southern mills were asking from 6@6½c. per lb. for domestic crude *peanut oil* in buyers' tanks. The demand was quiet. Oriental oil was held at 6¼c., sellers' tanks, f.o.b. Coast.

Waxes

Offerings of *carnauba wax* were fairly liberal and with the primary markets unsettled, prices here were barely steady at the recently reduced rates. Demand was quiet throughout the week. *Flor* was held at 60c. per lb., with the No. 1 at 58@59c. On the lower grades there was scattered interest in futures, but spot quotations were generally maintained at 17@17½c. per lb. for the No. 3 North Country. The crude oil situation had little or no effect upon the market for *paraffine wax*. Export demand covering forward contracts was comparatively quiet and with some selling pressure noted here prices were irregular. Domestic inquiry also was reported slow. Crude white scale wax, 122-124 deg. melting point, was offered in carlots at 2¾c. per lb. in some directions and 2½c. on firm business. Match wax closed at 3¾@4c. per lb. Refined paraffine, 118-120 deg. melting point, was offered at 3¾c. per lb., while 130-132 closed barely steady at 5@5½c. per lb.

The Iron and Steel Market

Pittsburgh, May 13, 1921.

As indicated in last week's report, it has become clear that the iron and steel trade is in no better condition than a month ago, and the continued failure of any definite improvement to develop now suggests that on the whole the condition must be regarded as worse. The proverbially dull summer season being now not far distant, the prospect is slim for any real improvement to occur in the near future. For some time past the common prediction in steel trade circles has been that there would be no important improvement before September or October, and that prediction holds good, with the appendage that conditions are likely to be somewhat worse meanwhile.

Using some estimates in conjunction with the monthly report of the American Iron and Steel Institute showing the production of steel ingots in April of the companies that make monthly reports, it may be concluded that in April the independent steel producers in general operated at about 22 per cent of capacity, and this with an operation of about 41 per cent by the Steel Corporation makes an operation for the whole industry of about 31 per cent of the estimated capacity of 52,500,000 tons of ingots per annum. The independents had operated at about 30 per cent in Januarv and February, rising to about 32 per cent in March. The

Steel Corporation's operations had declined from a 90 per cent rate in January, so that the two parties are now closer together.

There is no indication that operations have been any heavier in the past week than the average of April, there being rather room for the conclusion that there has been a slight decrease. The lead of the Steel Corporation over the independents seems likely to be maintained. While the corporation loses each month in its unfilled obligations —by 439,541 tons in the case of April—its constantly lowering rate of operation has made it that month by month the remaining unfilled tonnage would last a longer time. Thus at a 40 per cent operation the unfilled tonnage of 5,845,224 tons shown at the end of April would last a trifle over ten months. The independents have very little contract tonnage on books, as they had high prices last year and neither solicited nor were offered contracts for extended periods, so that they must now depend upon business picked up from time to time.

Test of Steel Prices

It is now a month since the steel market was equalized by the independents advancing their prices on most commodities and by the Steel Corporation reducing its prices. The new prices have been maintained to date, in a way, but it is the common remark that the prices have not been seriously tested as yet. It is predicted that the real test, whether the independents will all adhere to these prices, will come during the next thirty days; in other words, that if the prices last until the fore part of June they will hold through the summer. A new situation might be presented in the fall.

There are occasional reports of price irregularities, usually ascribable to a particularly attractive tonnage of business being offered. Thus an oil company is said to have been quoted $3 a keg on 4,200 kegs of nails, the regular price being $3.25, while the Ford Motor Co. is alleged to have bought all or a large part of a requirement of 4,000 tons of hot-rolled strips at 2.40c., the regular quotation being 2.75c. On ordinary lots of the various finished steel products there do not seem to be any cut prices being quoted at present.

While the steel market is regarded as being altogether stagnant it should be remembered that the industry has so grown that what was formerly a large tonnage is now a small tonnage relative to capacity. At the 31 per cent operation the steel industry appears to have shown for April there is represented about 250,000 net tons a week of the regular finished steel products, and that is really not a small tonnage for a hard times consumption, when the flow of steel into large construction work is very largely arrested. A 30 per cent operation today is equivalent to a 100 per cent operation of the capacity existing in 1903 or 1902, when the steel industry was regarded as being very large.

Pig Iron

The decline in pig iron prices continues, but at a relatively slow rate, there being only an occasional yielding, and then by a fraction of a dollar. When the market began to decline after reaching its peak at the end of last August the declines were recorded in steps of several dollars a ton at a time. On a 2,000-ton sale of basic pig iron by a merchant-furnace interest in the valleys $22 furnace has just been done, this representing a reversion of the control to the merchant furnaces, sales for several weeks preceding having been by steel works interests, at $22.50, the merchant furnaces holding aloof. Bessemer is offered at $24 valley, as against the previous nominal quotation of $25. Foundry iron is offered at $23.50 valley, a decline of 50c. in the week. At these prices pig iron cannot have much farther to go, and as a matter of fact pig iron prices in general are a slightly greater percentage below their Industrial Board levels than are finished steel prices, although the great advance that has occurred in freight rates since the Industrial Board adjustment bears more heavily upon pig iron relatively than upon steel.

Connellsville furnace coke could probably be bought at $3.25, a price that leaves little if any occasion for the consumers to demand a further liquidation.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.45
Acetone	lb.	$0.12½ – $0.12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.75	3.00 – 3.25
Acetic, 56 per cent	100 lbs.	4.00 – 4.25	4.50 – 5.50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9.35 – 9.40	9.50 – 10.00
Boric, crystals	lb.	.13½ – .14	.14½ – .15
Boric, powder	lb.	.15 – .15½	.16 – .16½
Citric	lb.	..... –	.45 – .46
Hydrochloric	100 lb.	1.50 – 1.65	1.75 – 2.00
Hydrofluoric, 52 per cent	lb.	.13 – .13½	.14 – .14½
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06½ – .06¾	.07 – .07½
Nitric, 42 deg	lb.	.07¼ – .07½	.07¾ – .08¼
Oxalic, crystals	lb.	.17 – .18	.18½ – .20
Phosphoric, Ortho, 50 per cent solution	lb.	.17 – .17½	.18 – .19
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.90 – 2.15
Sulphuric, 60 deg., tank cars	ton	..... –	12.00 – 13.00
Sulphuric, 60 deg., drums	ton	..... –	14.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 20.00	..... – .....
Sulphuric, 66 deg., drums	ton	22.00 – 22.50	23.00 – 23.50
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 – 24.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 – 26.00	26.50 – 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 – .....
Tannic, U. S. P	lb.	..... –	.90 – 1.00
Tannic (tech.)	lb.	.50 – .52	.54 – .57
Tartaric, crystals	lb.	..... –	.31 – .35
Tungstic, per lb. of WO	lb.	..... –	1.30 – 1.40
Alcohol, Ethyl	gal.	..... –	4.65 – 5.25
Alcohol, Methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.32 – .38
Alcohol, denatured, 190 proof	gal.	..... –	.40 – .45
Alum, ammonia lump	lb.	.04 – .04½	.04½ – .04¾
Alum, potash lump	lb.	.04 – .04½	.04½ – .05
Alum, chrome lump	lb.	.13 – .13½	.14 – .14½
Aluminum sulphate, commercial	lb.	.02½ – .02½	.02¾ – .03
Aluminum sulphate, iron free	lb.	.03 – .03½	.03½ – .04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.08 – .08½	.09 – .10
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.06½ – .06¾	.07 – .07½
Ammonium chloride, granular (gray salammoniac)	lb.	.07¾ – .08	.08¼ – .08¾
Ammonium nitrate	lb.	.08 – .08½	.09 – .10
Ammonium sulphate	100 lb.	2.50 – 2.75	2.80 – 2.90
Amylacetate	gal.	..... –	4.00 – 4.25
Amylacetate tech	gal.	..... –	2.50 – 3.00
Arsenic oxide, (white arsenic) powdered	lb.	.07½ – .08	.08¼ – .08½
Arsenic, sulphide, powdered (red arsenic)	lb.	.12 – .12½	.13 – .14
Barium chloride	ton	58.00 – 59.00	60.00 – 65.00
Barium dioxide (peroxide)	lb.	.19 – .20	.21 – .22
Barium nitrate	lb.	.10 – .10½	.10¼ – .11
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calc. hypochlorite)		..... –	..... – .....
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax (see sodium borate)		..... –	..... – .....
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.40 – .41	.42 – .45
Calcium acetate	100 lbs.	2.00 – 2.05	..... – .....
Calcium carbide	lb.	.05 – .05½	.05½ – .05¾
Calcium chloride, fused, lump	ton	27.00 – 29.00	30.00 – 32.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleach'g powder)	100 lb.	2.25 – 2.40	2.50 – 2.75
Calcium peroxide	lb.	..... –	1.25 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.63 – .68
Carbon bisulphide	lb.	.07 – .07½	.07 – .08
Carbon tetrachloride, drums	lb.	.10 – .10½	.11 – .12
Carbonyl chloride (phosgene)	lb.	..... –	.75 – 1.00
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chlorine, gas, liquid cylinders (100 lb.)	lb.	.08 – .09	.09 – .10
Chloroform	lb.	..... –	.38 – .40
Cobalt oxide	lb.	..... –	3.00 – 3.10
Copperas (see iron sulphate)		..... –	..... – .....
Copper carbonate, green precipitate	lb.	.20 – .21	.22 – .23
Copper cyanide	lb.	..... –	.50 – .62
Copper sulphate, crystals	lb.	.05¼ – .05½	.05¼ – .06
Cream of tartar (see potassium bitartrate)		..... –	..... – .....
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl Acetate Com. 85%	gal.	..... –	.90 – 1.00
Ethyl Acetate pure (acetic ether 98% to 100%)		..... –	..... – .....
Formaldehyde, 40 per cent	lb.	.14 – .14¼	.14½ – .15
Fusel oil, ref	gal.	..... –	3.00 – 3.25
Fusel oil, crude	gal.	..... –	1.75 – 2.00
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, C. P. drums extra	lb.	..... –	.17 – .17½
Iodine, resublimed	lb.	..... –	3.75 – 3.85
Iron oxide, red	lb.	..... –	.10 – .20
Iron sulphate (copperas)	100 lb.	.75 – 1.00	1.10 – 1.25
Lead acetate	lb.	..... –	.11½ – .13½
Lead arsenate, paste	lb.	.09 – .09½	.10 – .11
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.08½ – .09	.09½ – .10
Lithium carbonate	lb.	..... –	1.25 – .....
Magnesium carbonate, technical	lb.	.10 – .11	.11½ – .12
Magnesium sulphate, U. S. P	100 lb.	2.75 – 3.00	..... – .....
Magnesium sulphate, technical	100 lb.	..... –	1.10 – 2.25
Methanol, 95%	gal.	..... –	.75 – .77
Methanol, 97%	gal.	..... –	.78 – .82
Nickel salt, double	lb.	..... –	.14 – .14½
Nickel salt, single	lb.	..... –	.15 – .15½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb	..... –	.35 – .37
Potassium bichromate	lb.	.11½ – .12	.12½ – .12¾

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ .. – $	$0.30 – $0.35
Potassium bromide, granular	lb.	.... –	.16 – .25
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, crude	lb.	.06 – .06¼	.06½ – .07½
Potassium chlorate, crystals	lb.	.08¼ – .10	.10½ – .14
Potassium cyanide	lb.	.... –	.30 – .32
Potassium hydroxide (caustic potash)	lb.	.06 – .06¼	.06½ – .08
Potassium muriate	ton	50.00 – 50.50	.... – ....
Potassium iodide	lb.	.... –	2.75 – 3.00
Potassium nitrate	lb.	.09¼ – .09½	.10 – .12½
Potassium permanganate	lb.	.32 – .33	.34 – .35
Potassium prussiate, red	lb.	.33 – .35	.36 – .38
Potassium prussiate, yellow	lb.	.27 – .27½	.28 – .29
Potassium sulphate (powdered)	per unit	.... –	1.75 – 1.80
Rochelle salts (see sodium potas tartrate)		.... –	.... – ....
Salammoniac (see ammonium chloride)		.... –	.... – ....
Sal soda (see sodium carbonate)		.... –	.... – ....
Salt cake	ton	.... –	30.00 – 35.00
Silver cyanide	oz.	.... –	1.30 – 1.35
Silver nitrate	oz.	.... –	.41 – .42
Soda ash, light	100 lb.	2.10 – 2.15	2.25 – 2.50
Soda ash, dense	100 lb.	2.20 – 2.30	2.40 – 2.75
Sodium acetate	lb.	.04½ – .04¾	.05 – .05½
Sodium bicarbonate	100 lb.	2.35 – 2.50	2.60 – 2.85
Sodium bichromate	lb.	.07½ – .08	.08½ – .08½
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.05¼ – .05½	.05¾ – .06
Sodium borate (borax)	lb.	.06½ – .06¾	.07 – .07¼
Sodium carbonate (sal soda)	100 lb.	2.00 – 2.10	2.15 – 2.50
Sodium chlorate	lb.	.07½ – .07¾	.08 – .08½
Sodium cyanide	lb.	.22 – .24	.25 – .30
Sodium fluoride	lb.	.12 – .12½	.13 – .14
Sodium hydroxide (caustic soda)	100 lb.	3.60 – 3.75	3.80 – 4.00
Sodium hyposulphite		.... –	.03½ – .04
Sodium nitrate	100 lb.	2.90 –	3.00 – ....
Sodium nitrite	lb.	.06¼ – .07	.08 – .10
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½ – .04¾	.05 – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	.... –	.27 – .28
Sodium prussiate, yellow	lb.	.12½ – .12¾	.13 – .14
Sodium silicate, solution (40 deg.)	lb.	1.25 – 1.35	1.40 – 1.50
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.03¼ – .03½
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 – 1.75	2.00 – 2.25
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.05½ – .05¾	.06 – .06½
Sodium sulphite, crystals	lb.	.03¾ – .04	.04¼ – .04½
Strontium nitrate, powdered	lb.	.15 – .15½	.16 – .17
Sulphur chloride, red	lb.	.07 – .07¼	.07½ – .08
Sulphur, crude	ton	20.00 – 22.00	.... – ....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08¼	.09 – .10
Sulphur (sublimed), flour	100 lb.	.... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	.... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	.... – ....
Tin oxide	lb.	.... –	.40 – .42
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.11 – .11¼	.11½ – .12
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13½ – .14
Zinc oxide, XX	lb.	.08½ – .09	.09½ – .10
Zinc sulphate	lb.	.03¼ – .03½	.04 – .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities.

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.25 — 1.30
Alpha-naphthylamine	lb.	.35 — .40
Aniline oil, drums extra	lb.	.20 — .25
Aniline salts	lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)	lb.	.85 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 1.50
Benzidine, base	lb.	.85 — .90
Benzidine sulphate	lb.	.75 — .80
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.28 — .30
Benzyl chloride, tech.	lb.	.20 — .25
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech.	lb.	.32 — .45
Beta-naphthylamine, sublimed	lb.	2.00 — 2.25
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums	gal.	.70 — .80
Cresylic acid, 75-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.07 — .08
Diethylaniline	lb.	1.20 — 1.25
Dimethylaniline	lb.	.42 — .55
Dinitrobenzene	lb.	.30 — .32
Dinitroclorbenzene	lb.	.20 — .30
Dinitronaphthalene	lb.	.30 — .40
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.25 — .27
Dip oil, 25%, tar acids, car lots, in drums	gal.	.40 — .45
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.30 — 1.50
Meta-phenylenediamine	lb.	1.15 — 1.20
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.75 — 1.85
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08 — .08½
Naphthalene, flake	lb.	.08½ — .09½
Naphthalene, balls	lb.	.09½ — .10
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.16 — .18
Ortho-amidophenol	lb.	3.15 — 3.40
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.17 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.60 — 1.70
Para-amidophenol, HCl	lb.	1.75 — 1.80
Para-dichlorbenzene	lb.	.15 — .20
Paranitroaniline	lb.	.85 — 1.05
Para-nitrotoluene	lb.	.85 — 1.00
Para-phenylenediamine	lb.	1.95 — 2.00
Para-toluidine	lb.	1.25 — 1.60
Phthalic anhydride	lb.	.50 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .14
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.75 — 1.85
Resorcinol, pure	lb.	2.25 — 2.30
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.21 — .23
Salicylic acid, U. S. P.	lb.	.22 — .24
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.25 — 1.35
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.23 —	$0.25
Beeswax, refined, light	lb.	.25 —	.27
Beeswax, white pure	lb.	.45 —	.47
Carnauba, Flora	lb.	.60 —	.61
Carnauba, No. 2, North Country	lb.	.28 —	.30
Carnauba, No. 3, North Country	lb.	.17 —	.17½
Japan	lb.	.18 —	.18½
Montan, crude	lb.	.07 —	.08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½ —	.04
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.03 —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03½ —	.04
Paraffine waxes, refined, 125 m.p.	lb.	.04½ —	.04¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04¾ —	.05
Paraffine waxes, refined, 133-135 m.p.	lb.	.06 —	.06
Paraffine waxes, refined, 135-137 m.p.	lb.	.06½ —	.06¾
Stearic acid, single pressed	lb.	.09½ —	....
Stearic acid, double pressed	lb.	.10 —	....
Stearic acid, triple pressed	lb.	.11 —	.11¼

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.50 —	....
Rosin E-I	280 lb.	6.30 —	6.40
Rosin K-N	280 lb.	6.50 —	6.70
Rosin W. G.-W. W.	280 lb.	6.80 —	....
Wood rosin, bbl.	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.70 —	....
Wood turpentine, steam dist.	gal.	.68 —	....
Wood turpentine, dest. dist.	gal.	.66 —	....
Pine tar pitch, bbl.	200 lb.	.... —	7.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.... —	12.50
Retort tar, bbl.	500 lb.	.... —	12.50
Rosin oil, first run	gal.	.40 —	....
Rosin oil, second run	gal.	.44 —	....
Rosin oil, third run	gal.	.47 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.80
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.17 —	.17½
Upriver coarse	lb.	.11½ —	.12½
Upriver caucho ball	lb.	.14 —	.14¼
Plantation—First latex crepe	lb.	.18¼ —	....
Ribbed smoked sheets	lb.	.16½ —	.17
Brown crepe, thin, clean	lb.	.15 —	....
Amber crepe No. 1	lb.	.17 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.09 —	$0.09½
Castor oil, AA, in bbls.	lb.	.10 —	.10¼
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.11 —	.11½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.10¼ —	.10½
Cocoanut oil, Cochin grade, in bbls.	lb.	.11 —	.11½
Corn oil, crude, in bbls.	lb.	.07¼ —	.08
Cottonseed oil, crude (f. o. b. mill)	lb.	.05 —	.05¼
Cottonseed oil, summer yellow	lb.	.07½ —	....
Cottonseed oil, winter yellow	lb.	.07½ —	....
Linseed oil, raw, car lots (domestic)	gal.	.65 —	.66
Linseed oil, raw, tank cars (domestic)	gal.	.58 —	....
Linseed oil, in 5-bbl lots (domestic)	gal.	.68 —	.69

Olive oil, Denatured	gal.	$1.40 —	$1.60
Palm, Lagos	lb.	.07½ —	.07¾
Palm, Niger	lb.	.05¾ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.06 —	.06¼
Peanut oil, refined, in bbls	lb.	.10 —	.10½
Rapeseed oil, refined in bbls	gal.	.86 —	.88
Rapeseed oil, blown, in bbls	gal.	.92 —	.94
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.07½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.04¼ —	....
FISH			
Light pressed menhaden	gal.	$0.42 —	$0.43
Yellow bleached menhaden	gal.	.45 —	....
White bleached menhaden	gal.	.48 —	....
Blown menhaden	gal.	.80 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	1 .00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	10.00 —	....
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	50.00 —	60.00
Casein	lb.	.14 —	.16
Chalk, domestic, extra light	lb.	.05 —	.05½
Chalk, domestic, light	lb.	.04½ —	.05
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (kaolin), imported, lump	net ton	23.00 —	25.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Fla.	net ton	15.00 —	25.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	24.00 —	27.00
Graphite, Ceylon lump, first quality	lb.	.07½ —	.08
Graphite, Ceylon chip	lb.	.06 —	.06½
Graphite, high grade amorphous crude	lb.	.02½ —	.03
Pumice stone, imported, lump	lb.	.04 —	50
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.57 —	....
Shellac, orange superfine	lb.	.60 —	....
Shellac, A. C. garnet	lb.	.46 —	....
Shellac, T. N.	lb.	.50 —	....
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	14.00 —	15.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	20.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	10.00 —	14.00
Talc, imported	ton	35.00 —	40.00
Talc, California talcum powder grade	ton	18.00 —	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh		1,000	160
Carborundum refractory brick, 9-in.	less than carlot	1 000	1250.00
	carload lots	1.000	1100.00
Chrome brick, f.o.b. Eastern shipping points		net ton	80–100
Chrome cement, 40–45% Cr_2O_3		net ton	45– 50
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points		net ton	 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works		1,000	55– 60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works		1,000	45– 50
Magnesite brick, 9-in. straight		net ton	90
Magnesite brick, 9-in. arches, wedges and keys		net ton	105
Magnesite brick, soaps and splits		net ton	120
Silica brick, 9-in. sizes, f.o.b. Chicago district		1,000	45– 55
Silica brick, 9-in. sizes, f.o.b. Birmingham district		1,000	45– 55
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.		1,000	45– 55

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.15 —	.16
Ferrochrome, per lb. of Cr. contained, 4–6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	82.00 —	85.00
Ferromanganese, 76-80% Mn, English	gross ton	82.00 —	85.00
Spiegeleisen, 18-22% Mn	gross ton	32.00 —	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.50 —	....
Ferrosilicon, 10-15%	gross ton	50.00 —	55.00
Ferrosilicon, 50%	gross ton	80.00 —	85.00
Ferrosilicon, 75%	gross ton	145.00 —	150.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	5.00 —	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	gross ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.45 —	.50
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	45 —	.50
Coke, foundry, f.o.b. ovens	net ton	4.50 —	5.00
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.75
Coke, petroleum, refinery, Atlantic seaboard	net ton	15.00 —	16.00
Fluorspar, lump, f.o.b. mines, New Mexico	net ton	15.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.25 —	.30
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.14 —	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.14 —	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.12 —	.13
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	3.25 —	3.50
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.25 —	3.50
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.50 —	....
Zircon, washed, iron free	lb.	.03 —	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.75–13.00
Aluminum, 98 to 99 per cent	28.0@28.5
Antimony, wholesale lots, Chinese and Japanese	5¼@5¾
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	0.35
Monel metal ingots	0.38
Monel metal, sheet bars	0.40
Tin, 5-ton lots, Straits	33.00
Lead, New York, spot	5.00@5.20
Lead, E. St. Louis, spot	4.90@5.00
Zinc, spot, New York	5.40
Zinc, spot, E. St. Louis	4.90

OTHER METALS

Silver (commercial)	oz.	$.60¼
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	1.50@1.60
Cobalt	lb.	4.00
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	72.00–75.00
Iridium	oz.	250.00@300.00
Palladium	oz.	65.00@70.00
Mercury	75 lb.	46.00–47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.50–20.75
Copper bottoms	28.00–28.25
Copper rods	19.25–20.00
High brass wire	18.25
High brass rods	15.25
Low brass wire	20.25
Low brass rods	20.25
Brazed brass tubing	29.00
Brazed bronze tubing	34.25
Seamless copper tubing	22.00
Seamless high brass tubing	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	8.50@9.00	18.50	10.00	10.50
Copper, heavy and wire	8.00@8.25	16.50	9.50	9.50
Copper, light and bottoms	7.00@7.50	14.50	9.00	8.50
Lead, heavy	3.25@3.50	7.25	4.00	4.00
Lead, tea	2.15@2.30	5.25	3.00	3.00
Brass, heavy	4.25@4.50	9.50	7.00	10.00
Brass, light	3.00@3.25	8.00	5.00	5.50
No. 1 yellow brass turnings	4.00@4.25	9.50	5.50	6.00
Zinc	2.00@2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.50	$3.23	$3.23
Soft steel bars	2.50	3.00	3.13
Soft steel bar shapes	2.50	3.13	3.13
Soft steel bands	2.85	3.83	3.78
Plates, ¼ to 1 in. thick	2.50	3.30	3.23

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

LOS ANGELES—The American Aluminum Products Co., 717 Van Nuys Bldg., recently incorporated, has acquirerd property aggregating about 5 acres at Burbank, near Los Angeles, a site for the erection of a new plant, to consist of a number of 1-story buildings. Preliminary plans are under way. William E. Dursten is president and Elwell D. Moore representative.

PASADENA—The Kahler Sprinkler & Brass Mfg. Co., 367 South Fair Oaks Ave., will build a 1-story addition to its plant to be equipped as a brass foundry.

RICHMOND—Charles J. Hurrle, N w Hampton, Ind., is negotiating with the local Chamber of Commerce for a site for the erection of a new plant for the manufacture of window glass. Mr. Hurrle at one time operated a plant at Sacramento, Cal., but later sold the property. E. M. Downer and H. A. Johnston of the Chamber of Commerce are handling the details of the proposition.

REDWOOD CITY—The American Manganese Products Co. is reported to have purchased the local plant of the Aniline Dye Works, and will continue to operate the property.

WEST BERKELEY—John Lucas & Co., Inc., 322 Race St., Philadelphia, Pa., has acquired the local plant of the Glidden Co., manufacturer of paint, known as the Heath-Milligan unit, and will use the property for a branch plant for the manufacture of paint, varnish, etc.

SAN MATEO — The Minerals & By-Products Co., Denver, Col., is negotiating with the local Chamber of Commerce for a suitable site for the erection of a new plant. J. J. McGrath is president of the Chamber of Commerce and Daniel C. Imboden manager.

Connecticut

NORWALK—Charles H. Harris, president of Charles H. Harris, Inc., is planning for the erection of a new plant on property recently acquired on Main St., for the manufacture of glass for automobile windshield service. It will be 1-story, brick, and is estimated to cost about $65,000.

NEW HAVEN — The National Folding Box Co. has taken bids for the erection of a new building at its plant on James St. Westcott & Mapes, Inc., New Haven, is engineer.

Delaware

WILMINGTON — The Hercules Powder Co. has received permission from the United States District Court to acquire the physical properties and assets of thg Aetna Explosives Co.

Florida

WAUCHULA — W. G. DeVane, Trilby, Fla., and associates are planning for the erection of a new local fertilizer manufacturing plant to cost about $30,000 with equipment. J. B. Foreman, Vinnea, Ga., is also interested in the project.

CANAL POINT—The Florida Sugar & Food Products Co. has acquired property consisting of about 700 acres of land, and plans for the erection of a large sugar mill.

Illinois

CHICAGO—The Aetna Porcelain Enameling Co., 4701 Augusta St., has broken ground for the erection of a 1-story plant addition to cost about $10,000, to be located at Augusta St. and Kilpatrick Ave.

Indiana

INDIANAPOLIS—The Standard Oil Co. of Indiana has plans under way for the erection of a new oil refinery at Glenrock. Pressure stills will be installed to handle the residue from the plant of the Mutual Refining & Producing Co., which is also arranging for plant enlargements. The latter company is a subsidiary of the Elk Basin Consolidated Petroleum Co.

Maryland

FROSTBURG — The Big Savage Fire Brick Co. is planning for the rebuilding of its power plant and other buildings, recently destroyed by fire, with loss estimated at about $25,000.

FREDERICK—The O. J. Keller Lime Co. has commenced the construction of a new plant for the production of hydrated lime. The machinery will be arranged with individual motor drive. A lime storage building will also be erected. Richard K. Meade & Co., 13 East Fayette St., Baltimore, Md., are engineers for the work.

BALTIMORE—The new local plant of the American Sugar Refining Co., 117 Wall St., New York, now in course of construction, will require about 12 months to bring to completion. It will occupy a site of about 20 acres of land in the heart of the city, and is estimated to cost in excess of $5,000,000.

BALTIMORE — The American Foundry & Mfg. Co., South St., is planning for the erection of an addition to its foundry; a machine shop will also be built. The extensions are estimated to cost about $40,000. The company recently increased its capital to $200,000. John E. Shell, Jr., is manager.

Missouri

KNOB NOSTER—The Johnson County Brick Co., recently reorganized with a capital of $125,000, is planning for additions in its plant to increase the capacity from 30,000 to 50,000 bricks per day. A numb r of new kilns will be constructed at the plant, and considerable new machinery installed in the different operating depart ments. W. J. Mayes is president, and Frank L. Mayes treasurer.

RICHARDS—William E. Willis and W. J. Smiley of this place are organizing a company to build a new oil-refining plant in the vicinity of Springfield, Mo., with initial daily capacity of about 500 bbl. The plant will be erected on the unit type, and is estimated to cost about $100,000.

SPRINGFIELD—The Forster Mfg. Co., recently incorporated with a capital of $300,000, is planning for the erection of a new plant for the manufacture of cleaners, polishes and kindred products. The initial daily capacity will be about 15 tons of material. T. E. Forster, Neosho, Mo., is president, and D. D. Neblett secretary and treasurer.

New Jersey

WASHINGTON—The Washington Porcelain Co., manufacturer of electrical porcelain products, has completed the erection of two additions to its plant for increased operations, 50x96 ft. and 20x50 ft. respectively.

NEWARK—The Schenck & Schliete Co., Nesbitt St., manufacturer of paper boxes and containers, has leased a portion of the Quimby Bldg. at 21-39 Division St., totaling about 30,000 sq.ft. of floor space, for the establishment of a new plant.

NEWARK — The Reeves Mfg. Co. has broken ground for the erection of a new 2-story brass foundry at 318-26 Passaic St. to cost about $12,000. Arthur D. Reeve heads the company. Fitzsimmons & Richards, 207 Market St., are architects.

New York

BROOKLYN—Constant A. Benoit, operating a chemical manufacturing plant on Jerome Ave., has made application to the Board of Appeals for permission to build a new 3-story plant at 1702-18 Avenue Y, corner East Seventeenth St., for the manufacture of colors, enamels, varnishes and kindred products.

BROOKLYN—The Basic Chemical Corporation of America, 77 Seventh Ave., has leased property at 847 Union St. for a period of 5 years for a manufacturing plant.

LONG ISLAND CITY—Mayer & Lowenstein, Vernon Ave. near Bodine St., manufacturer of varnishes, etc., have awarded a contract to M. J. Irwin & Sons, 19 Hulst St., for the erection of a 1-story addition to cost about $17,000.

NEW YORK — The Cuba Cane Sugar Corp., 117 Wall St., is planning for the erection of a new sugar mill in eastern Cuba, with initial capacity of about 250,000 bags. At a later date extensions will be erected to double this output. The company is now operating 17 estates in Cuba.

NEW YORK—The Talc Products Co., 7 Hanover St., manufacturer of talc, soapstone, etc., is planning for the erection of a new mill in the vicinity of its present plant at Glendon, N. C. The proposed plant will have an initial capacity of about 100 tons of material daily. The company will also open up additional mining properties in this section.

NEW YORK—The International Petroleum Co., 120 B'way, has acquired an island in the Harbor of Barranquilla, Colombia, S. A., on the Magdalena River, as a site for the erection of a new oil refinery, to have a daily capacity of about 25,000 bbl., and which output will be increased at an early date. The company is now building a refining plant about 400 miles up the Magdalena River, to have an initial capacity of 2,000 bbl. per day. It is expected to have this latter plant ready for service at an early date.

Ohio

CINCINNATI—The Rossa-Ratliff Chemical Co has leased a 5-story building for the establishment of a new plant, replacing its works recently destroyed by fire.

Oklahoma

OKMULGEE—The Okmulgee Brick Co. is perfecting plans for the erection of a new local plant for the manufacture of paving brick and other burned clay products. R. E. Buckles is engineer.

Pennsylvania

PHILADELPHIA—The Crew Levick Co., 111 North Broad St., operating local oil refineries with total capacity of about 80,000 bbl. per month, has arranged for a bond issue of $1,500,000, a portion of the proceeds to be used for extensions, betterments and general operations. The company is a subsidiary of the Cities Service Co., 60 Wall St., New York.

SCRANTON—Fire May 5 destroyed the plant of the Diamond Paint & Oil Co., Seventh St., with loss estimated at about $125,000. It is said that the factory will be rebuilt.

Utah

MARYSVALE — The Industrial Potash Corp., Rockford, Ill., recently organized with a capital of $30,000,000, has plans under way for the erection of a large plant at Marysvale, for the manufacture of potash, fertilizer specialties and affiliated products. Potassium sulphate will be a primary feature of production. The new plant will have a capacity of about 10,000 tons of material per day, and with the development of raw material properties in this section is estimated to cost about $1,000,000. The company is headed by Jacob H. Krause and Ross P. Beckstrom, Rockford; and Floyd Bergland, Marysvale. It is represented by Louis Grollman, 111 West Monroe St., Chicago, Ill.

Virginia

HOPEWELL — The Hopewell Chemical Co., recently organized with a capital of $500,000, will soon commence production at its local plant for the manufacture of sodium sulphate and kindred specialties. A new building will be erected at an early date for increased capacity. The residue from nitre lakes near Roanoke, Va., will be used at the plant.

AQUIT STATION—The Fer-Sul Chemical Corp., has had plans prepared by the National Laboratories, 1313 H St., N. W., Washington, D. C., for the erection of a new plant for the production of sulphuric acid; the initial works will have a capacity of about 65 tons.

Washington

SPOKANE—The Western Soap Co., Ltd., has preliminary plans under way for the erection of a new plant at Sinto and Ash Sts. It will be 3-story, 92x100 ft., and is estimated to cost about $100,000 with machinery. Frank E. Irvine is president and manager.

Capital Increases, Etc.

THE QUEEN CITY BRICK & TILE CO., Cumberland, Md., manufacturer of brick, tile and other ceramic products, has filed notice of increase in capital from $100,000 to $200,000.

THE COSMO CHEMICAL CO., Muncie, Ind., has filed notice of dissolution under state laws.

THE UNITED ZINC SMELTING CORP., Eddyville, N. Y., has filed notice of increase in active capital from $3,000,000 to $4,000,000, with $1,000,000 in preferred stock and 60,000 shares of common stock, no par value.

THE VIRGINIA ORES CORP., Lynchburg, Va., has filed notice of increase in capital from $750,000 to $1,500,000. S. S. Johnson is vice-president.

THE DECATUR BRASS WORKS, Decatur, Ill., has increased its capital from $100,000 to $200,000.

THE BOLIVAR CLAY PRODUCTS CO., Pittsburgh, Pa., has filed notice of increase in capital from $100,000 to $225,000.

New Companies

THE LIBERTY LEATHER CORP., Boston, Mass., has been incorporated with a capital of $150,000 to manufacture leather products. William J. Fallon, Sr., is president; and William J. Fallon, Jr., 938 South St., Roslindale, Mass., treasurer.

THE WONDER CHEMICAL CO., Trenton, N. J., has been incorporated with a capital of $100,000 to manufacture chemicals and chemical byproducts. The incorporators are Felippo Benedetti and Melchlor F. Morton, Trenton.

THE PARAGON REFINING CO. OF NEW YORK, Buffalo, N. Y., has been incorporated with a capital of $100,000 to manufacture petroleum and other oil products. The incorporators are A. S. Matthews, I. C. Taber and C. A. Ulsh. Kent, Cumings & Means, Dun Bldg., represent the company.

THE ILLINOIS-WISCONSIN CONCRETE PIPE & TILE CO., 112 West Adams St., Chicago, Ill., has been incorporated with a capital of $50,000 to manufacture concrete products. The incorporators are George B. Harker, A. S. Sorenson and W. C. Whitcomb.

THE LITTLE TAMPICO PETROLEUM CO., Los Angeles, Cal., has been incorporated with a capital of $1,000,000 to manufacture petroleum products. The incorporators are William A. Meyer, H. H. Everett and Frederick Haas. I. Henry Harris, 1127 Title Insurance Bldg., represent the company.

THE O-JOY CHEMICAL CO., Syracuse, N. Y., has been incorporated with a capital of $25,000 to manufacture chemicals and chemical byproducts. The incorporators are F. L. Hogan, G. B. Stearns and H. B. Ansell, Burney Bldg.

THE WESTGARD SAW CO., 252 Empire Bldg., Seattle, Wash., has been incorporated with a capital of $100,000 to manufacture circular saws with high-speed steel insertible teeth. A. D. Cross is secretary and treasurer.

THE SILENT PRODUCTS CO., Elizabeth, N. J., has been incorporated with a capital of $125,000 to manufacture chemical specialties. The incorporators are Philip P. Scherer, Augustus J. and Welcome W. Bender, 208 Broad St.

THE SOLVENT PRODUCTS CO., Boston, Mass., has been incorporated with a capital of 400 shares of stock, no par value, to manufacture soap, dyestuffs, etc. Charles R. LaRose is president, and Edward W. Dougher, 21 Hyland St., Dorchester, Mass., treasurer.

THE HUDSON CEMENT PRODUCTS CORP., White Plains, N. Y., has been incorporated with a capital of $200,000 to manufacture cement products. The incorporators are A. D'Elie, L. E. Karle and W. G. Brown, Woolworth Bldg., New York.

THE LYNX SANITARY CO., 116 Market St., Newark, N. J., has filed notice of organization to manufacture chemical products, disinfectants, etc. Lincoln Arndt, 336 Belmont Ave., heads the company.

THE QUAKER CITY LEATHER CO., Philadelphia, Pa., has been incorporated with a capital of $25,000 to manufacture leather products. C. W. Toebe, 6448 Woodbine Ave., is treasurer.

THE SARDONYX MFG. CO., Dallas, Tex., has been incorporated with a capital of $50,000 to manufacture soaps and kindred products. The incorporators are J. E. Bryant, E. Morley Page, Dallas; and William H. Herring, Houston, Tex.

THE PENN PAPER CO., Erie, Pa., has been incorporated with a capital of $50,000 to manufacture and deal in paper products. John F. Young, 604 East Twenty-first St., is treasurer.

THE SPRINGFIELD BRONZE CO., Springfield, Mass., has been incorporated with a capital of $50,000 to manufacture brass and bronze products. Joseph R. Gould, 135 Ohio Ave., West, is president and treasurer; Robert S. Kneeland and Leonard Johnston are directors.

THE COLONIAL BRICK CO., Calvert Bldg., Baltimore, Md., has been incorporated with a capital of $50,000 to manufacture brick and other burned clay products. The incorporators are William F. Bell, Edward T. Reisler and Albin Widoff.

THE M. FRENVILLE CO., New York, N. Y., has been incorporated with a capital of $50,000 to manufacture leather products. The incorporators are M. Frenville, W. J. Delaney and L. G. Bernard. Price & Nathan, 19 Cedar St., represent the company.

THE J. BACH SPECIALTY CO., Secaucus, N. J., has been incorporated with a capital of $5,000 to manufacture chemicals and chemical byproducts. The incorporators are William Williams, George J. and Jacob Bach, 1170 Paterson Plank Rd.

THE CLIMAX OIL CO., Los Angeles, Cal., has been incorporated with a capital of $500,000 to manufacture petroleum products. The incorporators are J. L. Hines, H. L. Hazzard, Pasadena, Cal.; and Ernest Richter, Pomona, Cal.

THE INTERSTATE ALUMINUM TRADING CORP., New York, N. Y., has been incorporated with a capital of $100,000 to manufacture aluminum and other metal products. The incorporators are M. F. Cooperman, S. Kramer and S. Reiter. Davis, Donohue & Deitz, 140 Nassau St., represent the company.

THE TUFHEAD NOVELTY MFG. CO., Bridgeport, Conn., has been incorporated with a capital of $50,000 to manufacture varnishes, lacquers and kindred products. The incorporators are M. D. Stowe, G. L. Kelley and William Chapman, Bridgeport.

THE FARMERS' MUTUAL PHOSPHATE CO., Nashville, Tenn., has been incorporated with a capital of $600,000 to manufacture fertilizer products. W. R. Roach, A. Warden and John M. Petty are the incorporators.

THE FEDERAL REFINING CORP., New York, N. Y., has been incorporated under Delaware laws with a capital of $3,000,000 to manufacture petroleum products. Arthur W. Britton, 65 Cedar St., represents the company.

THE STEINHARDT LEATHER CO., Newark, N. J., has been incorporated with a capital of $50,000 to manufacture leather products. The incorporators are Lawrence J. Steinhardt, 203 McWhorter St.; Andrew Clark and Nathan Bilder.

THE WHITE-KNIGHT CORP., 5 North La Salle St., Chicago, Ill., has been incorporated with a capital of $250,000 to manufacture metal products. The incorporators are C. L. Sonen, H. Mulvaney and J. D. Maher.

THE HUNTINGTON-PACIFIC PETROLEUM CO., Los Angeles, Cal., has been incorporated with a capital of $500,000 to manufacture petroleum products. The incorporators are J. W. LaFrange and W. A. Davidson, Los Angeles; and James E. Jeter, Glendale, Cal.

THE KANSAUTAUQUA OIL CO. OF BUFFALO, Buffalo, N. Y., has been incorporated with a capital of $150,000 to manufacture refined oils. The incorporators are J. Volk and W. Stein. Harding & Harding, Buffalo, represent the company.

THE COMBINED MOSAIC & STAINED GLASS CORP., New York, N. Y., has been incorporated with a capital of $100,000 to manufacture mosaics and other ceramic products. The incorporators are M. Elson, M. A. Barrett and M. Gries. W. E. Foster, 60 B'way, represents the company.

THE MOTOR OIL & REFINING CO., Chickasha, Okla., has been incorporated with a capital of $50,000 to manufacture refined oil products. The incorporators are R. C. Parks, Duncan, Okla.; R. N. Stroup and B. B. Wofford, Grandfield, Okla.

THE NEW FEDERAL LEAD & ZINC CO., Miami, Okla., has been incorporated with a capital of $100,000 to manufacture lead, zinc and kindred metal products. The incorporators are W. V. French, A. W. Yakish and J. P. Whatley, all of Nowata, Okla.

THE UNITED CHEMICAL PRODUCTS CO., 500 Temple St., Los Angeles, Cal., has filed notice of organization to manufacture chemicals and chemical byproducts. Thomas Barrabee, 1806 Taberman St., heads the company.

THE ILLINOIS PETROLEUM CO., 327 South Lincoln St., Chicago, Ill., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture petroleum products. The incorporators are F. Letherstrom, Milton D. Simth and Brewster G. Spink.

THE FULTON LABORATORIES, New York, N. Y., has been incorporated with a capital of $5,000 to manufacture chemical products. The incorporators are R. J. Pfellisch, H. G. Kogen and T .R. Cardenas. Gordon, Winston & Goddard, 799 B'way, represent the company.

THE MARTRESE CORP., New York, N. Y., has been incorporated with a capital of $10,000 to manufacture refined oil products. The incorporators are E. Moesch, V. A. Roberts and A. W. Palmer, 27 Cedar Street.

New Publications

AMERICAN INDUSTRY IN WAR is the title of the report of the War Industries Board by Bernard M. Baruch.

THE ASSAY OF COAL FOR CARBONIZATION PURPOSES: A NEW LABORATORY METHOD, by Thomas Gray and James G. King; Tech. Paper 1 of the Fuel Research Board, Department of Scientific and Industrial Research, London.

HELIUM: ITS HISTORY, PROPERTIES AND COMMERCIAL DEVELOPMENT, by Richard B. Moore. Reprinted from the *Journal* of the Franklin Institute, February, 1921, by the J. B. Lippincott Co.

POWDERED COAL APPLICATION TO FOUR 2640-HP. BOILERS. Presented before the Mechanical Section, Engineers Society of Western Pennsylvania, Pittsburgh, Pa., by H. D. Savage, reprinted by the Combustion Engineering Corp. and given with its compliments.

USE OF PULVERIZED COAL UNDER CENTRAL STATION BOILERS, by John Anderson, chief engineer of power plants, Milwaukee Electric Railway & Light Co., which has been reprinted and issued by the Combustion Engineering Corp., New York, with its compliments.

THE COOLING OF QUENCHING OIL IN THE HEAT-TREATMENT OF STEEL, by Kenneth B. Millett. Compliments of the Griscom-Russell Co., New York.

NEW BUREAU OF MINES PUBLICATIONS: Bull. 195, Underground Conditions in Oil Fields, by A. W. Ambrose; Bull. 198, Regulation of Explosives in the United States, with Special Reference to the Administration of the Explosives Act of Oct. 6, 1917, by the Bureau of Mines, by Charles E. Munroe; Bull. 205, Flotation Tests of Idaho Ores, by Clarence A. Wright, James G. Parmelee and James T. Norton (this report was prepared in co-operation with the School of Mines, University of Idaho, and the Idaho State Bureau of Mines and Geology; Tech. Paper 228, The Relative Safety of Brass Copper and Steel Gauzes in Miners' Flame Safety-Lamps, by L. C. Ilsley and A. B. Hooker; Tech. Paper 246, Water-Gas Apparatus and the Use of Central District Coal as Generator Fuel, by William W. Odell (Illinois Coal Mining Investigations Co-operative Agreement); Tech. Paper 254, The Analysis of Sulphur Forms in Coal, by Alfred R. Powell; Tech. Paper 270, The Detection and Estimation of Platinum in Ores, by C. W. Davis; Tech. Paper 272, Permeation of Oxygen-Breathing Apparatus by Gases and Vapors, by A. C. Fieldner, S. H. Katz and S. P. Kinney; Tech. Paper 280, Accidents at Metallurgical Works in the United States During the Calendar Year 1919, by William W. Adams.

NEW BUREAU OF STANDARDS PUBLICATIONS: Sci. Paper 408, Effect of the Rate of Cooling on the Magnetic and Other Properties of an Annealed Eutectoid Carbon Steel, by C. Nusbaum and W. L. Cheney; Sci. Paper 409, A New Method for the Measurement of Photographic Filter Factors, by Raymond Davis; Tech. Paper 183, Notes on Small Flow Meters for Air, Especially Orifice Meters, by Edgar Buckingham; Tech. Paper 185, Experiments on Copper Crusher Cylinders, by Alexander I. Krynitsky.

NEW UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS: I: 9, Manganese and Manganiferous Ores in 1919, by H. A. C. Jenison (Mineral Resources of the U. S., 1919, Part I), published April 6, 1921; I: 10, Quicksilver in 1919, by F. L. Ransome, with a supplementary bibliography by Isabel P. Evans (Mineral Resources of the U. S., 1919, Part I), published April 2, 1921; I: 11, Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1919, Mines

Report, by Charles G. Yale (Mineral Resources of the U. S., 1919, Part I), published April 20, 1921; I: 30, Tungsten in 1918, by Frank L. Hess (Mineral Resources of the U. S., 1918, Part I), published March 21, 1921; II: 13, Phosphate Rock in 1919, by Ralph W. Stone (Mineral Resources of the U. S., 1919, Part II), published Feb. 25, 1921; II: 14, Magnesite in 1919, by Charles G. Yale and Ralph W. Stone (Mineral Resources of the U. S., 1919, Part II), published March 7, 1921; II: 15, Sand-Lime Brick in 1919, by Jefferson Middleton (Mineral Resources of the U. S., 1919, Part II), published March 5, 1921; II: 16, Salt Bromine and Calcium Chloride in 1919, by Herbert Insley (Mineral Resources of the U. S., 1919, Part II), published March 26, 1921; II: 17, Fuller's Earth in 1919, by Jefferson Middleton (Mineral Resources of the U. S., 1919, Part II), published March 9, 1921; II: 18, Talc and Soapstone in 1919, by J. S. Diller (Mineral Resources of the U. S., 1919, Part II), published April 14, 1921; II: 19, Mica in 1919, by Herbert Insley (Mineral Resources of the U. S., 1919, Part II), published March 28, 1921; II: 35, Coal in 1918, by C. E. Lesher (Mineral Resources of the U. S., 1918, Part II), published Dec. 6, 1920; II: 37, Coke in 1918, by C. E. Lesher and F. G. Tryon (Mineral Resources of the U. S., 1918, Part II), published April 22, 1921.

Manufacturers' Catalogs

W. W. SLY MFG. CO., Cleveland, O., has issued a new folder, No. 80, describing dust-collecting problems as solved by Sly dust arresters. The company is manufacturing a general line of apparatus for collecting industrial dusts and several of the installations which have been made are attractively illustrated in this publication.

THE BREGEAT CORP. OF AMERCA, New York City, has published a booklet on "The Bregeat Process for the Recovery of Volatile Solvents.

THE METAL & THERMIT CORP., New York City, has issued a booklet entitled "Instruction for the Use of Thermit Welding in Railroad Shops."

THE BOONTON RUBBER MFG. CO., Boonton, N. J., calls attention to a new catalog on "Boonton Bakelite," which is molded material for electrical insulations and for mechanical, chemical and other purposes. Many interesting illustrations are given.

THE JEFFREY MFG. CO., Columbus, O., has received from the press Catalog 257, on Jeffrey Standardized Scraper Conveyors. It features both single and double strand conveyors designed to handle all kinds of loose products in manufacturing and mining industries, power plants, retail coal yards, canning plants, sugar mills and practically all other industries. Instruction, specifications and dimensions are given. Copies will be sent to interested persons upon request.

EDWARD R. LADEW CO., New York, has recently issued two catalogs. "The Proof Book" is a compilation of evidence of the dependability of Hoyt leather belting in service, with a brief discussion of some of the fundamentals of belting economy. The illustrations are from actual installation, showing Hoyt belts in service over various periods up to forty-four years, together with illustrations of a variety of difficult drives. "Ladew Leather Belting" is an 80-page catalog describing the manufacture of Hoyt leather belting from the rough hide to the finished product. Belting rules and tables are given, with a data sheet for analysis of belt drives for highest economy. Belting accessories are also included.

FRANK D. CHASE, INC., Chicago, Ill., announces two new catalogs. "Industry" is the title of one which contains a number of interesting articles, among which there is one by Frank D. Chase on "The Employer's Analysis of an Engineer." "Factories that Fit" is the title of the other publication. The purpose of the book is to convey the Chase conception of sound engineering design in factory construction. Many illustrations are given which show examples of the company's work.

THE PYROLECTRIC INSTRUMENT CO., Trenton, N. J., has issued a price list of apparatus for electrometric and colormetric determinations of hydrogen ion concentrations.

THE WHITING CORP., Harvey, Ill., has issued catalog 156, on Ladle. The catalog is well illustrated.

THE J. L. MOTT IRON WORKS, New York City, has issued three new catalogs. No. 3-A deals with Metal Melting Pots and Furnaces, coal, gas and oil; No. 5 deals with Stills, Vacuum Pans and Condensers; No. 10 is on Acid Eggs, Blow Cases and Filters. Each booklet is well illustrated.

THE THWING INSTRUMENT CO., Philadelphia, Pa., calls attention to Bulletin 19, which treats of Type A thermoelectric pyrometers, both indicating and recording, which are particularly adapted for chemical and metallurgical industries. The booklet is illustrated.

THE DUST RECOVERING & CONVEYING SYSTEM, Cleveland, O., has iuused bulletins 12 and 501, the first of which outlines the development of dust-collecting equipment and the second of pneumatic conveying equipment. Bulletin 12 is well illustrated, showing the simplest equipment used in dust recovery together with the Dracco Perfecto, the latest type of dust recovery installation. Bulletin 501 shows the simple practice in pneumatic conveying where some dust may escape through the pump, where air is filtered after passing the pump, where coarse and fine contents are discharged separately and where coarse and fine contents are discharged together. The receiver can be arranged in this system to meet any discharge requirements.

GEORGE J. HAGAN CO., Pittsburgh, Pa., is issuing a new gas producer bulletin describing the Hagan hand-stoked producer and also pointing out the service which the company can render in connection with producer installations, together with interesting illustrations and blue prints. This company has also issued Bulletin LF 101 on Liquid Fuel Burners for open-hearth and other regenerative furnaces. Descriptions and illustrations are given together with blue prints.

THE HARDINGE CO., New York, announces the publication of the sixth of its series of Grinding Data Bulletins. This bulletin presents interesting data on the operation of the large sized Hardinge mills in the mining field, not only where the stage reduction is the custom, but also where the single stage method is in use. The whole series of bulletins embodies information on Hardinge mills and other types of grinders.

THE MINE & SMELTER SUPPLY CO., New York, Denver, Salt Lake City and El Paso, has published Bulletin 64 descriptive of Wilfley concentrating tables. In addition to the generally understood use of these devices in ore treatment, they are recommended for such purposes as the recovery of metallics from refuse in brass foundries and for the washing of inferior coal.

THE YOUNGSTOWN BOILER & TANK CO., Youngstown, O., has issued a 19-page bulletin illustrating and describing Youngstown tanks and showing how standardized size save money. Much other valuable information for tank users is contained in this bulletin.

C. F. PEASE CO., of 813 North Franklin St., Chicago, has issued an attractive new catalog, S-41, for the engineers' surveyors field and office supplies.

W. E. PRINDLE CO., engineer, Columbus, O., in a new catalog illustrates and describes the design and construction of the Prindle driers. In these driers the application of the drying agent, whether it be direct heat, indirect heat or steam-heated air, have been worked out so as to give the best results. Types 10 to 15 inclusive are illustrated and described. General construction of the driers is described together with the guarantee, replacement patents and a note to prospective customers as to what data are required to give quotations, etc.

THE GRISCOM-RUSSELL CO., New York, has issued several new bulletins. G-R Regenerative Compressor is the title of Bulletin 350, which describes and illustrates a unique patented apparatus just placed on the market. This apparatus is designed for installation on Reilly evaporators, self-scaling, and its use during period of reduced evaporator capacity is said to permit evaporator operation at an efficiency much greater than can be secured by the evaporator operating alone, single effect. Bulletin 315 describes the G-R multiscreen filter, a redesign of the Reilly water filter and grease extractor. Bulletin 330 covers the Reilly evaporators, self-scaling, for marine service.

THE CUTLER-HAMMER MFG., CO., Milwaukee, Wis., calls attention to a number of new leaflets and booklets. A four-page leaflet, entitled "C-H Iron-Clad Solenoid." describes electric solenoids for operating brakes, clutches, valves and similar devices where a straight line motion is desired. Electrically operated brakes are described and illustrated in a 16-page booklet, which is known as Publication 850. Publications 875 and 876 are of interest to men of the gas industry. The former is a 12-page booklet descriptive of the Thomas meter, which is used for measuring large quantities of commercial gases and air, while the latter describes the Thomas calorimeter, which gives graphical records of the total heating values of gases.

THE CHICAGO PNEUMATIC TOOL CO., New York, calls attention to two new publications. Bulletin 639 illustrates and describes BQ-46 hammer drill and Bulletin 607 contains a comprehensive description and several interesting applications of the Chicago pneumatic oil-engine-driven compressors. These machines are built in both stationary and portable types. A comparison of their operating cost versus steam-driven compressors appears on pages 20 and 21.

THE VANADIUM CORP. OF AMERICA, New York, has issued an attractive catalog on Vanadium, in war and peace. The booklet describes and illustrates the many uses of vanadium products.

DE LAVAL STEAM TURBINE CO., Trenton, N. J., has just published "Ten Years Progress in Water Works Pumps." The first half of the book is devoted to a discussion of the economy of different types of pumping units and to a description of notable installations of turbine-driven centrifugal pumps in municipal pumping plants, while the second part of the book takes up the testing of steam turbines and centrifugal pumps and the measurement of head and discharge, which should be of interest to engineers generally. The book will be distributed free of charge to interested persons.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN IRON AND STEEL INSTITUTE will hold its nineteenth general meeting in the Hotel Commodore, New York, on Friday, May 27. There will be three sessions: A forenoon session beginning at 10 o'clock daylight saving time (9 a.m. Eastern time); an afternoon session at 2; and a banquet in the evening at 7.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magaine from time to time.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: May 20, Society of Chemical Industry; June 10, American Chemical Society.